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THE EFFECT OF INCENTIVES ON ACCURACY OF DISCRIMINATION MEASURED ON THE GALTON BAR

BY

HUGHBERT C. HAMILTON, Ph.D.

ARCHIVES OF PSYCHOLOGY

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I. HISTORICAL SURVEY AND INTRODUCTION

An important focal point in a dynamic psychology is the study of motivation, particularly the nature of incentives and their effects. If prediction and control are the aim of the science of psychology, certainly here lies one of the keys to the goal. Many ostensibly different types of incentives have been applied to many different forms of behavior. Much of the observation has not taken the form of systematic experiment. And most of the studies which might deserve the latter term have been too poorly controlled or have employed too few subjects to permit of any reliable conclusions. However, there are summarized below, those studies in which relatively simple and specific external incentive stimuli have been applied to the more simple and accurately measurable performances, and studies of visual discrimination of length, it being the purpose of this investigation to study the effect of specific incentive stimuli upon the latter performance.

1. Animal Studies

The not unequivocal distinction made between drive and incentive stimulus is useful here. As implied above, the determination of the conditions varying the strength of hunger, sex, and thirst drives, for instance, does not so much concern us as does the measuring of the effects of external stimuli acting as incentives. The latter has been attempted in receptor studies, for example.

Hoge and Stocking[9] were interested in the relative value of punishment and reward. They used electric shock for punishment and food for reward. The behavior motivated was brightness discrimination, after the Yerkes method. Only two female rats, one albino and one black and white, constituted each of their three groups. One group received both punishment and reward, another was punished for wrong responses, and the third was rewarded for correct responses. Both rats receiving both punishment and reward learned, one rat receiving just punishment, and neither of the rats receiving just reward learned. This scarcely justifies the conclusion that the combined incentives are more effective than punishment alone, and punishment is more effective than reward alone.

Dodson,[3] in 1917, built up discrimination habits in white rats, also for the purpose of comparing reward and punishment. Shock was the stimulus for punishment, and food for reward. Punishment was given thus: if the rat went to the dark box, it received shock, and had to return to its nest through the light box; if it went to the light box, it simply passed on through to its nest. Reward was given thus: if the rat went to the light box it received food; if it went to the dark box, it had to return to its nest through the light box. Supposedly four degrees of punishment and of reward were used, i.e., four strengths of shock, and four degrees of hunger. For all degrees of intensity, punishment was more effective than reward. There was both an optimum strength of shock and an optimum degree of hunger, which were less than the highest intensities used.

Warden and Aylesworth[18] tested the findings of Hoge and Stocking in respect to the comparison of reward and punishment by the discrimination method. They employed ten white rats in each of three groups. One group received only food for correct responses, another only shock for wrong responses, and the third received food for correct responses and shock for wrong responses. Combined reward and punishment proved to be most effective, punishment alone ranked next, and reward alone was least effective. In fact, the group receiving only food failed to learn, under the rather strict criteria employed.

2. Studies Employing Human Subjects

An early study which forms a sort of negative approach to the problem is that made by Judd.[11] He wanted to discover the effect of practice when the subject had no knowledge of the results of his performance. On a table was placed a line running at an angle from the subject. The table was divided in the center by a screen. The subject's task was to place a dot behind the screen at a point which would fall within the exact continuation of the line. Nine different angles were employed and each angle was tried twenty times on each of ten days. The one subject employed was unable to make improvement without any knowledge of how well or how poorly he was doing.

As late as 1923, Spencer[15] repeated Judd's experiment, using four subjects. Using the average error as a measure of results, instead of the constant error as Judd had done, Spencer reports three of his four subjects making improvement.

One of the earliest studies of effect of incentives was made by Wright,[19] on work and fatigue. Four subjects were required to work to exhaustion with the ergograph, but under three different conditions. In the first condition the subjects had no knowledge of how well or how much they were doing; they were merely told to work as hard and long as they could. The second condition furnished incentive by placing blocks under the carriage of the ergograph, and requesting the subjects to see how many times they could reach the block. In the third the subjects watched the records of their activities on a smoked drum, upon which there had previously been a line drawn, and were requested to do their best to reach the line as many times as they could. The records showed that under both conditions of incentive, the subjects performed more work, and were able to keep at it a longer time, than when they had no goal or incentive set for them.

A similar study was made by Arps.[1] Three subjects worked on the ergograph. During some of the work periods the subjects could see the tracings they were making on a smoked drum; and during other work periods the subjects had no knowledge of their results. Arps finds increased efficiency of the periods during which the results are known over those during which the results are unknown.

Johanson[10] worked with reaction-times under three conditions: ordinary finger reaction to sound stimulus; same, but subject received an electric shock if he did not get his finger from the key quickly enough, i.e., if his reaction was slow; same, but subject was told the time of his previous reaction before receiving the stimulus for the next reaction. Three subjects were employed. Three hundred and fifty reactions were taken in each series for two of the subjects, and five hundred for the third subject. Both of the latter conditions effected shorter times, the second condition having a greater effect than the third. Johanson concludes that this is due to the fact that "The factors of positive and negative incentive caused the state of keener attention to be maintained."

Rexroad[14] gave electric shock for punishment in continuous multiple choice reactions to color. The main part of his experiment employed sixty subjects, thirty of whom received shock for inaccurate responses. Five colors were presented one at a time in random order, and the subject reacted to each by pressing one of five keys, according to a code. Both correct and incorrect responses were recorded; and when an incorrect response was made the subject was shocked by means of electrodes fastened to the hand. Each subject reacted for two and a half minutes with each of ten codes. The punished subjects were 15 per cent more accurate, or learned faster. The author divides the effect of the punishment into three sorts: disruptive, incentive, and instructive.

Incentives in the nature of verbal encouragement and discouragement were used on simple performances by Gates and Rissland.[6] The tests used were the three-hole test for motor coordination and the color-naming test. Seventy-four Barnard College students were divided into three groups. After the initial test, one group was complimented, one was given adverse criticism, and to the third nothing was said. This was in each case followed immediately by a second test. In general, encouragement effected more improvement than discouragement, and discouragement more than mere repetition; but the differences were slight.

Thorndike[17] had five subjects estimate in centimeters the length of fifty strips of paper when they had a 10-centimeter strip with which to compare them. This was followed by seven or eight training periods, during which the experimenter said "right" or "wrong" after removing each strip from the subject's view. Then came the final test period, like the first series, in which the experimenter said nothing. A comparison of the final with the first test period showed the average per cent of reduction in error to be 61. Seven subjects who had about the same amount of training, but were not told "right" or "wrong," made an average reduction in error of —7 per cent. In a second experiment reported in the same article, twenty-four subjects, blindfolded, drew a 3- (or 4-, 5-, or 6-) inch line in response to the appropriate command. The first test consisted in drawing one hundred and fifty lines of each of the four lengths. This was followed by seven training periods, like the first, except that the experimenter said "right" if the line was drawn within one-eighth inch of the correct length in the case of the 3-inch line and one-fourth inch in the case of the other three lengths, and "wrong" if the line were longer or shorter. This was followed by a series like the first test without any comment by the experimenter. An average gain in per cent of correct lines, on the last test over the first, of 12 was made. Six subjects went through the training periods without any statement of "right" or "wrong" being made. Three of these improved and three made more errors.

Despite the facts that few subjects were used, that they did not all have the same number of training periods, that the intervals of time between training periods varied, and that the results for the six control subjects in the second experiment were not at all clear cut, and despite other possible interpretations, Thorndike considers "That these experiments are crucial as a demonstration that the consequences of a connection work back upon it to influence it."

3. STUDIES IN VISUAL DISCRIMINATION OF LENGTH

In view of the type of performance employed in this study, namely the visual discrimination of length on the Galton Bar, it is of interest to note the studies in which the performance was similar, even though they were made under normal conditions, i.e., without incentives. We shall here consider only those studies in which comparisons of horizontal lengths were made by the method of average error, and when the normal and comparison distances were presented simultaneously, for these are the more similar.

Fechner[4] made the horizontal difference between two points of a compass equal to a standard distance set between the two points of another compass. Both compasses lay on the table side by side and only the points were visible. For each standard length used, he made 120 trials with the comparison length on the right of the standard and the same number with it on the left.

Volkmann, reported by Fechner[4] (p. 215ff.), used three vertical threads against a dark background. For each series of trials, the distance between two of the threads was constant, constituting the standard length, while the third thread had to be adjusted until the distance between it and the middle thread appeared equal to the standard. Volkmann was the only subject and made 96 trials with each standard, half of them with it on the left and half on the right.

Appel, also reported by Fechner[4] (p. 222), a student of Volkmann, extended the latter's work, using his apparatus and technique.

Chodin[2] used a fine black pencil line drawn on a paper. The standard length was marked off near the middle of this line by two short cross lines. Chodin indicated lengths equal to the standard by placing a short cross line both to the right and to the left of the standard. In one experiment 150 trials were made with each standard, and 120 trials in another.

Münsterberg[13] had, for one of his experiments, distances marked off by white cardboard points visible against a green background. A distance of 60 mm. separated the standard from the comparison length. The latter was varied by sliding the farther point. Münsterberg as subject made 20 trials with each standard, half of which were with the comparison length on the left and half on the right.

Higier[8] used two strips of black paper against a strip of glass with a ½ mm. slit between them through which light came. A vertical thread across the slit constituted a dividing line, and black pieces slid in front of the bar to adjust the length on either side of the thread. The black pieces were moved by means of threads which were fastened to them. The subject's head was in a head rest which was 50 cm. from the apparatus. Only the right eye was used. Higier was the only subject and he made 50 trials, half right and half left, each day for ten days with each standard.

Fischer[5] used the Münsterberg apparatus, except that the points marking off the length were of metal. He employed fewer standard lengths but more trials, namely eighty, for each.

Stephanowitsch[16] employed a self-registering apparatus. The standard length was that between two marks placed on a paper beneath a glass plate. The glass plate could be made to slide over the paper by turning a wheel. A scratch on the glass had to be moved as far from one of the marks as was the other, thus making a distance between one of the marks and the scratch equal to that between the two marks. A marker attached to the glass recorded the length of its movement. In the major part of his experiments Stephanowitsch performed 100 trials for each of the standard lengths used.

Kiesow[12] used black lines ⅓ mm. in width on two pieces of cardboard. A piece of paper covered the comparison length and was drawn along until the subject said to stop, after which he was allowed to make a finer adjustment himself. The cardboards lay horizontally on a table before the subject. The one subject performed 100 trials with each standard length.

All these experiments on the visual discrimination of length were performed with one of two purposes, namely, to test the applicability of Weber's law or to study psychophysical methods, which do not concern us here. To these ends each experimenter employed a number of different standard lengths. With the exception of Stephanowitsch[16] who used five subjects, the results are those of but one subject, usually the experimenter himself, and are generalized without hesitation.

One of the lengths employed by six of the above investigators is of more interest to us than the rest of their work because of its equivalency with that used in some of the work about to be reported. Although the results of these investigations are not directly comparable because of the great differences in the apparatus employed, in the number of trials, in the distance of the subjects from the lengths being compared, and in the freedom of movement of the head and eyes, the findings when the standard length was 200 mm. are shown together in Table 1.

TABLE 1

Experimenter	*No. of Subjects*	*Distance from Eyes mm.*	*No. of Trials*	*Measure*	*Standard 200 mm. %*
Volkmann	1	800	96	Rel. A.E.	0.96
Appel	1	370	192	Rel. A.E.	3.09
Appel	1	300	132	Rel. A.E.	3.38
Münsterberg	1	600	20	Rel. V.E.	2.50
Higier	1	500	500	Rel. A.E.	2.55
Kiesow	1	400*	100	Rel. A.E.	0.65

* Approximate.

Of more value to the present experiment would be data showing the effect of practice. Unfortunately these investigators do not report their original data but present only very meagre summary tables. The only one who presents any data to show the course of the average error throughout the experiment is the most recent investigator, Kiesow.[12] His data on this point will be discussed on p. 42.

We find that in animal work incentives in the nature of "reward" and of "punishment" have been used and compared, when applied to brightness discrimination. In general, a combination of the two seems to have been most effective, with punishment ranking next, and reward last. In human studies we find incentives effecting improvement in such simple activities as ergographic work and speed of finger reactions.

The first exact knowledge of the operation of any factor or process must come through observation of a simple delimited case of that factor acting under known and constant conditions upon a simple, isolated, measurable bit of behavior. To deal immediately with complex cases, containing many variables, results only in confusion.

A type of performance which meets these demands, but upon which, our survey reveals, the effect of incentives* has scarcely been studied, is that of visual discrimination. This experiment attempts to employ simple incentive stimuli, whose natures and intensities are constant and comparable; and to use them under constant and known conditions; and to have them act upon this simple and measurable bit of behavior, visual discrimination of length. These stimuli take on a positive or negative character according to the nature of the instructions issued. Thus, when they occur as a consequence of correct reactions they may be said to be positive (reward), and when they follow incorrect reactions they may be said to be negative (punishment).

It is not surprising to find improvement in any performance following upon receipt of an incentive stimulus, when it includes some indication of the type or nature of the error which has been made, that is, some indication of the direction or steps to be taken in effecting improvement. But it is not so clear that improvement will follow when the incentive stimulus consists only in something like punishment or reward, without any indication of the nature of the error committed, or of the steps to be taken to avoid it. Visual discrimination of length is a performance which lends itself well to an investigation of this point, and the major portion of the present experiment has been arranged to that end. It is possible to use an incentive stimulus which satisfies the demands stated in the paragraphs above, and which may be interpreted as a reward for good discrimination or as a punishment for poor discrimination, without giving any indication of the direction of the error.

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* Throughout this report the terms incentive, reward, and punishment are used to indicate the interpretation or attitude of the subject toward the situation, while incentive stimulus refers to the external physical stimulus.

II. EXPERIMENTAL SITUATION

1. Apparatus

The apparatus was designed to meet three chief requirements: (a) to measure visual discrimination of length without having any visual stimuli present except the actual length being judged; (b) to present incentive stimuli which would take on the nature of punishment for poor discrimination and of reward for good discrimination, without giving any indication of the nature of the error, and which would be comparable in respect to quality and intensity, and to present them automatically; (c) to measure the time taken for each discrimination made, without the subject having knowledge of being timed. These requirements were met in the following manner.

(a) A modification of the Galton Bar was employed in presenting the lengths to be discriminated, and in measuring the accuracy of the performance. An illuminated glass bar was mounted horizontally in the center of a black field, in a dark room. The illuminated bar was three-quarters of an inch wide and thirty-six inches long. The black field was four feet wide in the vertical direction, and eight feet in the horizontal direction. The lower edge of the bar was four feet six inches from the floor.

The bar itself was composed of opal glass. The source of illumination was a row of ten 15-W. lamps, whose centers were three and three-quarters inches apart, of the same length as the bar, and running parallel behind and above it. The light was then reflected onto the bar by a mirror, placed at an angle of 45°, as shown in Diagram 1. This combination results in a strip or length of light of sensibly even intensity of illumination.

A vertical hair line marked the center of the bar. Two black shields were made to slide close against the bar, one on either side of the hair line, thus cutting out the light, and making it possible to vary the length of the strip of light seen on either side of the center hair line. The shield on the subject's left of the center could be set by the experimenter at any point, making a standard line of light of any desired length. The subject could vary the length to his right of the center, by turning a control rod, as used with the regular Galton Bar,

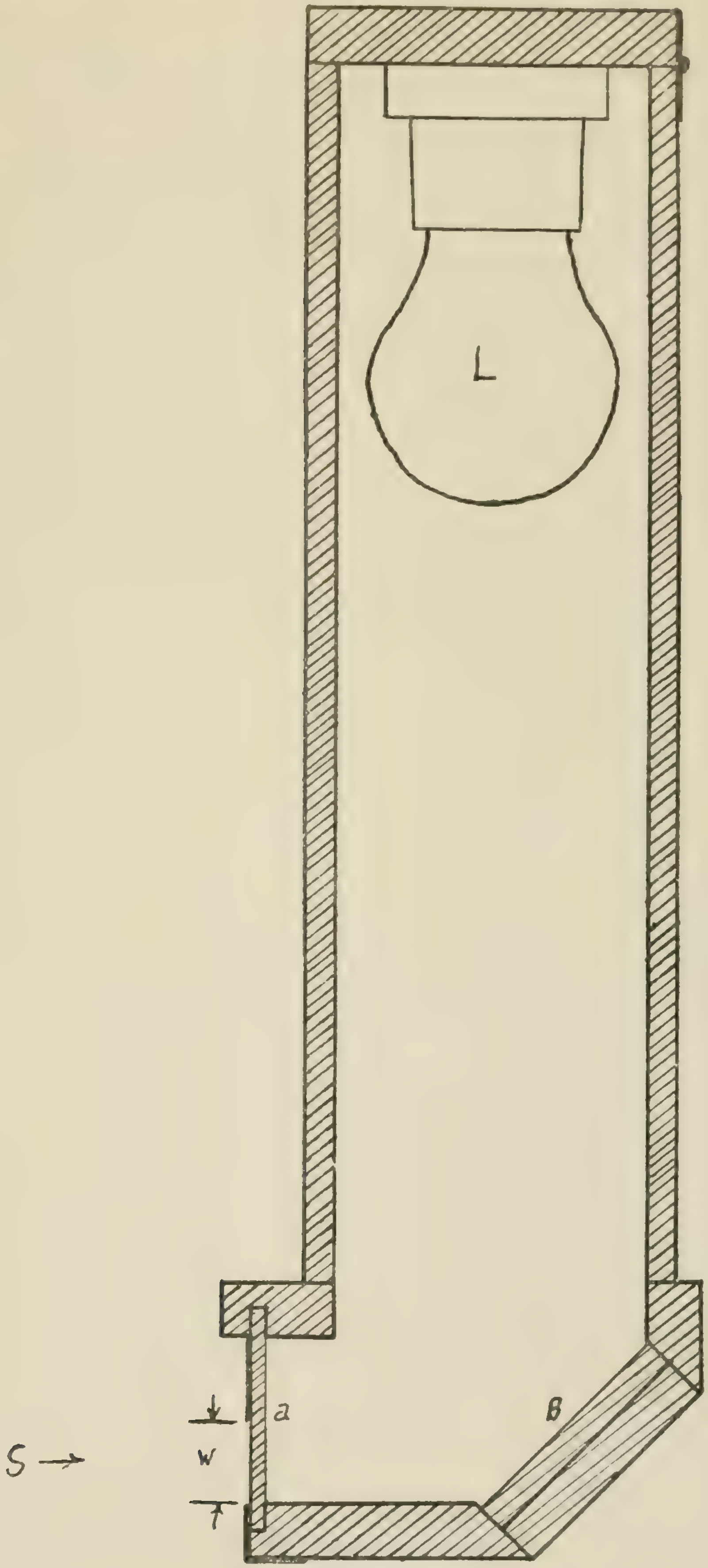

DIAGRAM I.

Sketch Showing Cross-Section of Bar, and Method of Lighting It.

L = lamp a = opal glass.
B = mirror w = part of "a" through which light is allowed to pass.
S→ = subject looks at this side of bar.

as made by C. H. Stoelting & Company. A scale back of the bar made it possible to read in millimeters the distance or length exposed on each side of the center.

It will be seen that this is in effect a Galton Bar; but one that consists in lengths of light seen in the dark, thus eliminating all visual stimuli except the actual lengths being discriminated.

The subject was seated with his eyes approximately on a level with the bar, and six feet in front of the center of it.

(b) The incentive stimulus, which took on the nature of punishment for poor discrimination, or of reward for good discrimination, consisted in the sound of an electric door-bell. The stimulus was presented in the following manner. On a table immediately in front of the subject was a push button. After each discrimination the subject pressed this push button, which lighted a small, blackened lamp on the experimenter's side of the apparatus, indicating that the subject had completed his discrimination, or was through judging. Now the bell was also in circuit with this push button. To give punishment, the bell rang when the subject pressed his button, if he had made the length too long or too short, but did not ring if the correct length had been made. To give reward, the bell rang when the subject pressed his button, if he had made the correct length, but did not ring if the length had been made too long or too short. In circuit with the bell was a mechanism which automatically closed the circuit, whenever the length was too long or too short, in the case of punishment, so that the bell would respond according to the above formula, whenever the subject pressed his button. If it were reward that was being given, the same mechanism automatically opened the circuit when the length was too long or too short, and closed it when the length was correct, thus here also properly controlling the ringing of the bell when the subject pressed his button.

The mechanism, which determined whether or not the bell would ring when the subject pressed his button, was composed as follows: A long brass rod was attached to the shield which the subject moved in adjusting the length, and moved with and parallel to it. Two contact points or fingers extended out from the rod, and by means of collars and set screws each could be set at any point along the rod. As the rod moved, these contact points or fingers slid along a surface

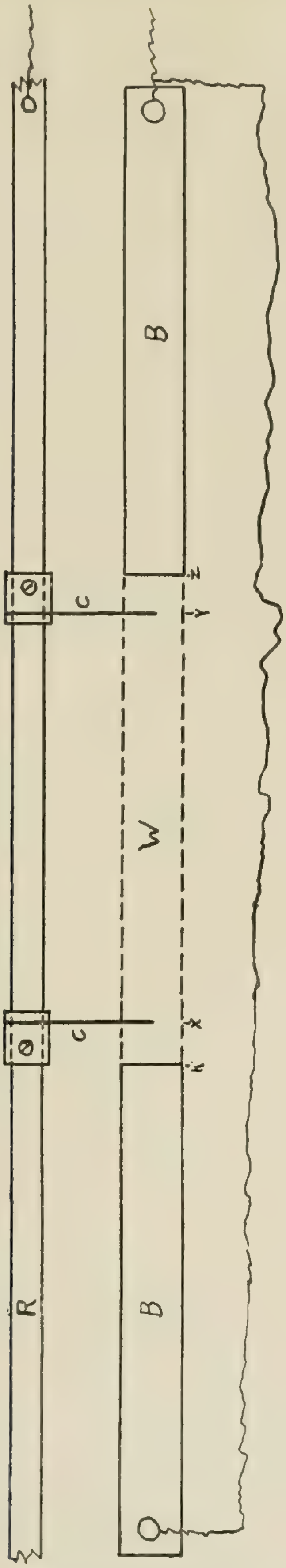

DIAGRAM 2.

Sketch of Mechanism Controlling the Ringing of the Bell
R = brass rod. C, C = adjustable contact points. B, B = brass strips.
W = strip of wood. Wavy line = wiring.

consisting of two brass strips separated by a strip of wood, as shown in Diagram 2. Now in the case of punishment, any desired amount of variation from the true length might be allowed before the bell would ring, by setting the contact points that distance along the wood strip from the brass strips. As shown in the diagram, the contact points are as they might be when the correct length of light has been set, i.e., equidistant from the brass strips. But if the subject had set the length as much as the distance kx in error in either direction, the bell would ring. Thus the subject was allowed an error of kx without causing the bell to ring when he pushed his button.

In the case of reward, reversing a double pole, double throw switch, as shown in Diagram 3, cut this mechanism out, putting the bell in direct circuit with the subject's push button. At the same time the mechanism was placed in circuit with a relay, which could break the bell circuit. Thus, if the contact points were on the wood strip—i.e., if the length was correct—the relay did not operate, and the bell would ring when the subject pressed his button. But if one of the contact points was on a brass strip—i.e., if the length was either too long or too short—the relay broke the bell circuit, and the bell would not ring when the subject closed his push button.

The determination of what distance was to be set as too long and too short, i.e., what amount of variation from the true length would be called wrong, will be explained later with the procedure.

This method of presenting the incentive stimuli automatically, gives mechanical accuracy and certainty as to the conditions and manner of presentation, and so rules out the chances of error and variability which might be great were the experimenter himself presenting or controlling the incentive stimuli. At the same time it permits of the greatest flexibility in the amount of error which is to be considered as error, requiring only that this be determined, as it should be, before and not during the making of a trial.

It may also be pointed out that the requirement of equating the incentive stimuli in respect to quality and intensity had been met, for they consisted in the same bell operated by the same strength of current. Yet in the one case, the bell very definitely took on the nature of punishment, and in the other case the nature of reward.

(c) The time taken in making each discrimination was measured by a Stoelting electrically controlled stop watch. A contact point was fastened to, but insulated from, the brass rod, described above, which moved with the shield regulating the length of the line of light. This point was so placed that it passed over a copper point on a stationary part of the apparatus, as soon as the subject moved the shield away from the zero point or center, when starting to adjust the bar of light. The contact thus made started the watch. The subject's push button also operated a relay which closed the watch circuit,

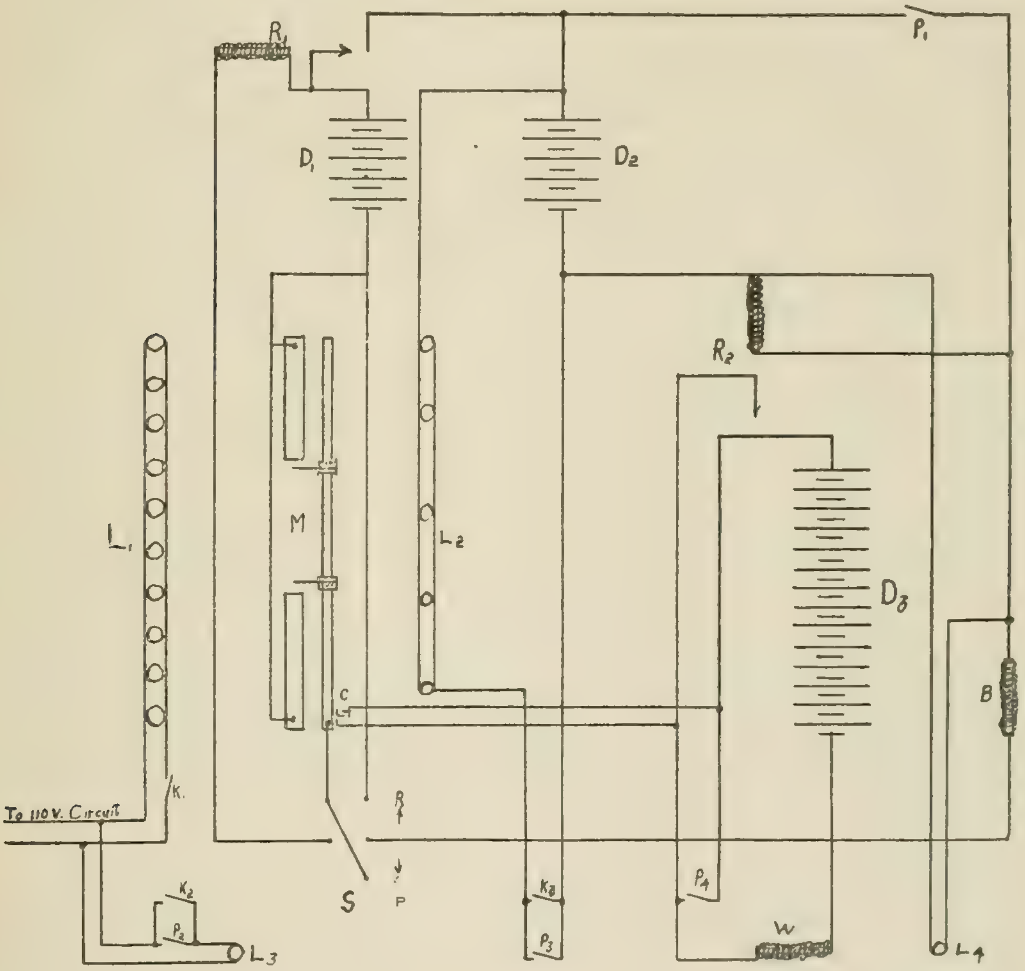

DIAGRAM 3

WIRING DIAGRAM

L_1, ten 15W. lamps lighting the bar. L_2, five 6V. lamps to illuminate the mm. scale. L_3, lamp to illuminate the watch. L_4, indicator lamp operated by subject's push button. P_1, subject's push button. P_2, P_3, P_4, push buttons. K_1, K_2, K_3, knife switches. S, double pole, double throw switch; when closed in the direction P, the circuits are set for punishment; when closed in the direction R, the circuits are set for reward. M, mechanism controlling the ringing of the bell. B, bell. R_1, relay for breaking the bell circuit. R_2, relay for stopping watch. C, contact points for automatically starting watch. W, watch. D_1, D_2, D_3, dry cells.

stopping the watch. Thus the time was recorded from the point when the subject began to make his line until he pressed the button, indicating that he had completed his judgment. Then as the experimenter moved the shield back to the zero point or center, the contact points which started the watch again closed the circuit in passing, automatically bringing the watch back to the zero point. A third switch was placed in the watch circuit, in parallel with the other two, and was located on the experimenter's control board. This was for the purpose of readjusting the action of the watch to the subject's procedure if, as occasionally happened, it was thrown out of step by a subject pressing his push button twice, instead of once.

The noise of the watch and the magnet operating it was ruled out by placing this instrument on a thick pad of felt and covering it with two bell jars. This arrangement was found to be effective, and still allowed the experimenter to read the watch easily, and to remove it to do the necessary winding. The subject had no occasion to suspect that he was being timed.

Both relays employed, the one in one of the bell circuits and the other in the watch circuit, were sound-proofed in a manner similar to that used with the watch.

The electric circuits whose uses are described above are all shown in Diagram 3.

2. Subjects

Sixty undergraduate students in psychology in Barnard College, Columbia University, comprised the subjects for this experiment. These were, of course, all girls. The six groups described below contained ten subjects each.

3. Procedure

The task was the same for all of the groups. The incentive was the variable. The experimenter exposed a standard length of 120 millimeters on the subject's left of the center line, and the subject was required to make the length on his right *twice as long as the standard.* Each trial started with the shield at the center line, so that there was no length showing on the right of the center. By turning the flexible control rod, the subject moved the shield out until he thought he had exposed a line twice as long as the standard. He was not allowed to move the shield back toward the center. Nothing was said about time, the subject being allowed to fall into his own pace in setting the lengths. When satisfied that he had exposed enough line, the subject pressed his push button. This stopped the watch, and lighted the experimenter's indicator lamp. The experimenter then observed and recorded the length set and the time taken; and moved the shield back to the center. The subject immediately proceeded with the next trial.

The experiment occupied about an hour on two different days. On the first day all of the groups were given a practice series of fifty trials, in ten series of five trials each, with a rest period of approximately one minute between each series of five. On the second day, at the same time of day, the subject first performed a series of five trials, in the same manner as on the first day. At this point the incentive series was introduced. This consisted in forty-five trials, under the condition of incentive, and was performed in nine series of five trials each, with a rest period of approximately one minute between each series of five. As the incentive was varied from group to group, this series must be described separately for each group.

a. Punishment Group

At the beginning of the incentive series the subjects in the Punishment Group were told that from this point on the procedure would be the same as before with this difference: that if they got the length wrong, a bell would ring when they pushed the button. They were also told that of course one would rarely ever get the length *exactly* right, so that they would be allowed a little leeway before it would be considered wrong.

The criterion of wrong, i.e., the amount of variation in either direction from the correct length which would be allowed without causing the bell to ring, was determined as follows. The average error each subject made on his own fifty practice trials was taken as a basis for him. Before the series began, the sliding contact points, described above, were set to allow that amount of variation from the correct length, before the bell would ring. For example, if a subject made an average error of twelve millimeters on his fifty practice trials, the mechanism was set so that the bell would ring only when he had made the length as much as twelve millimeters too short, or as much as twelve millimeters too long. But, as the experiment progressed, whenever a subject's average error for any series of five trials became smaller than his average error had previously been, the amount of variation allowed was narrowed to equal the new and smaller average error. The rest period between each series of five trials permitted the experimenter to calculate the average error for the series just completed, and to make the necessary changes, if any, in the mechanism which controlled the ringing of the bell. The subject, of course, had no knowledge of this changing criterion of error.

This method helps to equate the punishment from subject to subject, since the criterion of error, and therefore the administration of the punishment, was always dependent upon each subject's own previous performance.

b. Reward Group

The procedure for the Reward Group was the same in all respects as that for the Punishment Group, with this important difference: that the bell rang when the length had been made correctly, while nothing occurred when the length had been made too short or too long, and the subject was so instructed.* The criterion of right and wrong, and hence the administration of the incentive stimuli, was adjusted as above to each subject's own performance as the experiment progressed.

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* Clearly the silence which sometimes followed the pressing of the push button was a part of the total stimulus situation which confronted the subject. Thus to the subjects in the Punishment Group the bell indicated failure and silence indicated success, and in the case of those in the Reward Group the bell indicated success and silence failure. Bell and silence might be thought of as two parts of a total configuration which confronted the subject. But it was the bell which was the differentiating, determining feature of the stimulus situation. The subjects of the Punishment Group, for instance, were definitely trying to avoid the bell, they were not trying to attain silence. Their expressive responses, as swearing and chagrin, were made when the bell rang, they did not show delight at the silence. Likewise the Reward Group were oriented toward the bell, not the silence, and gave expressions of delight when the bell rang, but were not expressive in response to silence. Also, one is confronted with a metaphysical problem when he attempts to differentiate the silence which followed the pressing of the push button from that which had been existing all of the time and which continued to exist until the next time the bell rang. In view of these considerations the bell has been referred to exclusively as the incentive stimulus, throughout this paper; but perhaps one should bear in mind the presence of silence throughout the experiment as a kind of neutral reciprocal factor.

c. Control Group

The subjects in this group performed the entire fifty trials on the second day in exactly the same manner as they had in the practice series, the first day; but the bell was not introduced.

d. Guess-with-Punishment Group

The procedure for the Guess-with-Punishment Group was exactly the same as for the Punishment Group, with this addition: that each time the bell rang, i.e., each time an error had been made, the subject was required to guess the direction of his error.

e. Told-with-Punishment Group

For this group the procedure was exactly the same as for the Punishment Group, with this addition: that each time the bell rang the experimenter told the subject the direction of his error. The experimenter did this by simply saying either "long" or "short," after the bell had rung.

f. Knowledge Group

The determination of an error here was the same as for all the other incentive groups. That is, as the average error decreased, the amount of variation allowed was narrowed accordingly. But the bell was not used. Instead, after each trial, the experimenter said simply either "long," or "short," or "right." These words were always said, as nearly as possible, in the same matter-of-fact tone of voice.

III. STATEMENT OF RESULTS

The sort of measure which has to be dealt with is amount of error in millimeters. Also, since the unit of performance in the procedure of the experiment was a series of five trials, the most appropriate grouping of the data is by the same series of five trials. Hence the average error of a series of five trials has been employed as the unit in the consideration and presentation of the data. The average error in millimeters, of each series of five trials made by each subject is given in the Appendix, pages 49-54. The results for the Control Group may be found in Table 12; the Punishment Group, Table 13; the Reward Group, Table 14; the Guess-with-Punishment Group in Table 15; the Told-with-Punishment Group in Table 16; and the Knowledge Group, Table 17.

The effect of the incentive in the experiment is measured by the change in the magnitude of the average errors made during the incentive series from those made during the practice series, when this change is considered in relation to the performance of the Control Group. To obtain an adequate index of a group of subjects, the amount of change made by each subject must first be considered in relation to that subject's own performance during the practice series. Otherwise, the variation from subject to subject in absolute amount of error would vitiate the group index. Therefore, the average error made by each subject for each series of five trials has been considered as a percentage of his average error in his own fifty practice trials. Thus it becomes possible to average the performance of all of the subjects within a group for each series of five trials, obtaining an index of group performance throughout the progress of the experiment.

This method of making the group measure of change, effected by the incentive stimulus, an average of the relative and not the absolute change in each individual's performance is at the same time perhaps the best method of equating the groups, in respect to ability in this type of performance.

The average of each group shown in the above tables, i.e., the group index of the percentage which the average error of each series of five trials is of the average error of the fifty practice trials, is given in Table 2, page 25.

Analysis of the table reveals that all of the groups per-

TABLE 2

Average Error of Each Five Trials as a Percentage of the Average of the Fifty Practice Trials.

Group		*C*	*P*	*R*	*GwP*	*TwP*	*K*
Series of five trials							
PRACTICE	1st	134	165	146	139	191	108
	2nd	108	98	99	97	108	98
	3rd	84	82	96	105	81	96
	4th	103	98	92	84	95	85
	5th	82	73	80	94	83	103
	6th	87	104	73	95	97	111
	7th	98	90	94	109	107	77
	8th	96	102	109	95	71	109
	9th	104	89	104	100	75	93
	10th	109	99	108	84	90	118
INCENTIVE	1st	102	107	79	75	102	98
	2nd	84	85	97	70	76	71
	3rd	92	82	72	66	82	71
	4th	97	71	79	70	58	77
	5th	113	60	67	69	65	57
	6th	117	63	76	46	38	57
	7th	105	47	69	49	43	38
	8th	101	38	55	46	38	56
	9th	116	42	37	39	31	53
	10th	127	24	26	15	20	45

formed in the same manner on the practice series, i.e., the fifty trials of the first day. The average error of the second five trials shows a considerable decrease over that of the first five trials; and that of the third five shows a further decrease. But from that point on there is no further decrease, the curves fluctuating around a practically level line, a sort of normal error. The Knowledge Group is an exception only in that it was not so far from its normal error at the beginning.

The incentive series, i.e., the second day's trials, under the condition of incentive, present quite a different picture. In the first place, the Control Group, which had no incentive stimulus, merely continuing its practice, and therefore forming a standard or norm with which to compare the different incentive groups, made but little change in its errors. And this change was in the nature of a slight increase, the average errors through successive series of five trials starting at 102% and increasing to 127% of the average error of its fifty practice trials.

The Punishment Group started at 107% and decreased its average error in a very regular manner to only 24% of the average error made on its fifty practice trials.

The Reward Group started at 79% and decreased its average error to 26% of its first day's performance.

The Guess-with-Punishment Group decreased its average error from 75% to only 15%; the Told-with-Punishment Group from 102% to 20%; and the Knowledge Group from 98% to 45%.

As all the conditions of incentive employed effected a decrease in the average error, and not even a single subject within any group has to be excepted from this statement, the first question of the experiment is thus answered: incentives did effect a gain in accuracy of discrimination.

Therefore, the second question of the experiment resolves itself into the following. Throughout the incentive series, i.e., during the period of work measured by the experiment, how much can the error be decreased, how much improvement can be effected, by each condition of incentive employed? The best measure of this would be the performance on the last unit of the series, i.e., the average of the last five trials. This is shown in Table 3.

TABLE 3.

AVERAGE ERROR OF THE LAST FIVE TRIALS OF THE INCENTIVE SERIES AS A PERCENTAGE OF THE AVERAGE OF THE FIFTY PRACTICE TRIALS.

Group	*C*	*P*	*R*	*GwP*	*TwP*	*K*
Percentage	127	24	26	15	20	45

To give meaning to the differences between the groups, their reliability has been computed by the standard method, and is shown in Table 3, page 27.

Table 4 shows: (1) that compared with the Control Group each of the conditions of incentive may be said to have effected a reliable decrease in error, or improvement in discrimination. This difference is not only statistically reliable, but is large. (2) That there is no reliable difference between the performance of the Punishment and of the Reward Groups. (3) That there is no difference between the Guess-with-Punishment and the Told-with-Punishment Groups; nor between these groups and the Punishment and Reward Groups. (4) That the Knowledge Group made a reliably less amount of

TABLE 4.

RELIABILITY OF THE DIFFERENCES BETWEEN THE EFFECTS OF THE DIFFERENT INCENTIVES, AS MEASURED BY THE AVERAGE ERROR OF THE LAST FIVE TRIALS AS A PERCENTAGE OF THE AVERAGE OF THE FIFTY PRACTICE TRIALS.

Groups	*Diff.*	*Sigma Diff.*	$\frac{\textit{Diff.}}{\textit{Sigma Diff.}}$
C and P	103	17.1	6.0
C and R	101	17.3	5.8
C and GwP	112	16.8	6.7
C and TwP	107	16.9	6.3
C and K	82	17.8	4.6
P and R	2	5.9	0.3
P and GwP	9	4.1	2.2
P and TwP	4	4.7	0.9
P and K	21	7.2	2.9
R and GwP	11	4.7	2.3
R and TwP	6	5.3	1.1
R and K	19	7.7	2.5
GwP and TwP	5	3.2	1.6
GwP and K	30	6.4	4.7
TwP and K	25	6.8	3.7

improvement than did the Guess-with-Punishment and the Told-with Punishment Groups; and that near reliability was reached between the Knowledge Group and the Punishment and Reward Groups; at the same time, however, the Knowledge Group showed real improvement in its performance, thus occupying a sort of mid-point.

IV. DISCUSSION OF RESULTS

1. No Improvement Through Repetition Alone

The performance of all the groups during their practice series, and especially the Control Group throughout its entire performance, shows that, beyond the first few trials, the mere repetition of this act of discrimination did not effect any improvement. Practice alone, without any incentive or any knowledge of the quality of the performance, did not bring about any decrease in the error. This is in agreement with the findings of Judd,[11] who also devised a situation in which the subject received no knowledge of the accuracy of his performance, and found that he made no improvement. It is probably rarely true that an individual is in a situation where there is neither incentive nor knowledge of the quality of the performance. But here, in those parts of the experiment under discussion, there was certainly no knowledge of the quality of the performance. And if there was any incentive, it was of the general sort, as a general desire to do well, or to please the experimenter, which proved to be not in the least effective, unless the improvement of the first five trials might be ascribed to it.

2. Equivalency of the Effects of Punishment and of Reward

The effect of the incentive stimulus, when it took on the nature of punishment, and when it took on the nature of reward, was found to be the same. Under incentive, the Punishment Group decreased its average error to 24% of the average error of its practice series, and the Reward Group decreased its average error to 26% of the average error of its practice series. These may be considered as equivalent decreases.

In previous studies, where a comparison has been attempted between these two contrasting types of incentives, the usual finding has been that of the greater effect of punishment. But it should be noted that in all of these studies there has been considerable discrepancy in the nature of the incentive stimuli compared, their quality, their intensity, the manner of presentation, etc. For example, in animal studies, shock has been the standard punishment stimulus, and food the standard reward stimulus. And in studies with human subjects, perhaps shock was the punishment stimulus, and a knowledge of scores made, the reward stimulus. To attempt to compare the effectiveness of shock and of food is like trying to compare two loaves of bread by saying that one of them was 12 inches long, and the other weighed 12 ounces. They have entirely different qualities, and so cannot be adequately equated, or even compared.

In this study we have carefully controlled the quality, intensity, and method of presentation of the stimulus for these two conditions of incentive. The *physical* aspects of the stimuli were equivalent, for they were identical; and they were presented in the same carefully regulated manner, as described with the apparatus and the procedure. When the incentive stimulus took on the nature of punishment, the bell rang for failures or errors in discrimination. The incidental, spontaneous behavior of the subjects in the Punishment Group gave evidence of the fact that a real punishment was being given. The subjects often swore at the bell, made "faces" when it would ring, and said that it was quite a shock to them, and all adopted the attitude of trying to keep the bell from ringing. While these spontaneous bits of behavior on the part of the subjects in the Reward Group, when the bell rang for successes, were quite the opposite. They would give exclamations of delight upon hearing the bell, and sigh, and say, "What a relief," "That's better," etc. And all tried hard to make the bell ring.

Whether an incentive stimulus is in the nature of a punishment or of a reward depends not upon the physical stimulus itself, but upon the conditions under which it is given, and so might be said to be an interpretation on the part of the subject, a subjective thing. It is readily conceivable that under certain conditions an electric shock might be considered as a reward, and that food might become punishment. The factors, the effects of which we are trying to measure, then, are not the physical stimuli at all, but the additional elements given to them by the conditions under which they are presented, and by the subject who responds to them. Obviously, the physical stimuli themselves, and the conditions under which they are given, must be equated, however, before we can begin to make comparisons. For if they are different, we may then be measuring those differences, the effects of those factors, rather than the effects of the punishment and reward themselves.

The results of this study, then, force us to conclude that when the physical factors are equated, and when the punishment and reward are placed over a common denominator, as they have been here, they too are equivalent in effect. Or stated another way, as far as the actual effect upon the subject's visual discrimination of length as measured on the Galton Bar is concerned, it makes no difference whether the incentive stimulus is one to be sought after or to be avoided, reward or punishment.

3. Analysis of the Improvement

a. The Constant Error and the Variable Error

Examination of the constant error and of the variable error throws some interesting light on the improvement made.

Table 5 shows the magnitude of the constant error in millimeters for each of the groups. The magnitude of the constant error is given for successive groups of 15 trials. The first item in the table is the constant error for the 2nd, 3rd, and 4th series of five trials; the second item in the table is the constant error for the 5th, 6th, and 7th series of five trials; etc. Some of the subjects within a group had constant errors carrying a plus sign, and others had constant errors carrying-

TABLE 5.

Magnitude of the Constant Error in mm.

Group		*C*	*P*	*R*	*GwP*	*TwP*	*K*
Series of five trials							
PRACTICE	2nd, 3rd, 4th	13.8	16.6	10.7	16.5	8.0	12.2
	5th, 6th, 7th	12.3	16.2	6.3	19.5	8.8	16.5
	8th, 9th, 10th	11.0	19.5	9.7	16.4	6.9	16.1
INCENTIVE	2nd, 3rd, 4th	11.5	8.9	6.1	7.5	3.4	6.2
	5th, 6th, 7th	15.5	4.4	5.5	5.4	2.3	3.2
	8th, 9th, 10th	12.8	2.4	2.1	3.3	1.9	1.6

The constant errors of the individual subjects, from which are computed the group values, shown in Table 5, are given in Tables 18-23, pages 55-60.

ing a minus sign but the constant errors of the individual subjects within a group have here been averaged without regard to signs. Hence, the table shows relationships of only the magnitude of the constant errors.

We see practically no change in the magnitude of the constant error throughout the practice series of all the groups, and the Control Group continues to show no change throughout its second day's trials. In each of the five incentive groups, however, the magnitude of the constant error shows regular and marked decrease, throughout the second day. This is of importance in view of the fact that, except in the TwP and K groups, the incentive stimulus gave to the subject no indication of the direction of his error.

Table 6 shows the variable error in millimeters for each of the groups. The table follows the same form as the one for constant error. The variable error is given for successive groups of 15 trials, and these are designated as series of five trials.

As in the case of the constant error, we see practically no change in the variable error throughout the practice series of all the groups, nor any change throughout the second day's trials of the Control Group. But the incentive groups show

TABLE 6.

VARIABLE ERROR—IN MM.

Group		*C*	*P*	*R*	*GwP*	*TwP*	*K*
Series of five trials							
PRACTICE	2nd, 3rd, 4th	8.2	8.3	7.6	8.4	8.0	8.5
	5th, 6th, 7th	8.0	8.8	7.4	6.8	8.6	7.5
	8th, 9th, 10th	8.9	8.6	7.7	7.2	7.6	8.3
INCENTIVE	2nd, 3rd, 4th	7.3	8.2	7.8	7.4	7.2	8.1
	5th, 6th, 7th	7.4	6.8	6.4	7.3	5.8	6.4
	8th, 9th, 10th	8.4	4.6	4.3	4.7	3.5	6.6

The variable errors of the individual subjects, from which are computed the group values, shown in Table 6, are given in Tables 24-29, pages 61-66.

a regular and marked decrease in their variable errors throughout the second day. The Knowledge Group is the single exception to this, its variable error showing but little decrease.

A possible hypothesis which suggests itself in explanation of the improvement made under incentive is that the subject upon realizing that he had made an error was able to judge its direction, and so modified his next response in the right direction. Such an hypothesis would account for the decrease in the constant error, but it is not adequate to account for the decrease in the variable error. For the decrease in the variable error shows that the improvement made under the various conditions of incentive was not merely one of orientation in respect to direction of error, but also brought with it decrease in variability of performance.

However, in one case, that of the Knowledge Group, the decrease in constant error was not accompanied by a decrease in variable error. Thus, here, in the relationships between the constant errors and the variable errors, is to be found substantiation of the finding that the knowledge situation was not as effective as the others.

b. Time of Making Discrimination

The time taken in making a discrimination might be of value when considered in relation to the accuracy of the performance.

The records of the time taken in making each discrimination have been treated in the same manner as the records of error. The average time per trial for each series of five trials has been taken as the unit. To make meaningful the average of a group of subjects, the average time for each series of five trials for each subject has been considered as a percentage of the average time per trial of that subject's own 50 practice trials. And the group average for each series of five trials consists in the average of these precentages.

Tables 30-35, pages 67-72, show the absolute time per trial in seconds for each series of five trials, for each subject.

Table 7, below, then, shows the group averages of the average time of each five trials as a percentage of the average of the 50 practice trials.

We note that: (1) during the practice series all of the groups showed a slight, gradual decrease in time; (2) during the second day's trials the Control, Punishment, and Reward Groups continued their slight, gradual decrease in time, in a practically equivalent manner; (3) as soon as the incentive stimuli were introduced, the time of the Guess-with-Punishment Group made a sharp increase, from which point there ensued again the slow, gradual decrease; but the time did not finally become as low as it had during the practice trials; (4) upon the introduction of the incentive stimuli, the Told-with-Punishment Group began a slight, gradual increase in its time; (5) the Knowledge Group, upon the introduction of the incentive stimuli, made a small, immediate increase, and thereafter remained on a level.

The improvement in discrimination in the Punishment and Reward Groups did not interrupt the gradual decrease in the time per trial throughout the experiment, which decrease went on exactly as it had in the Control Group, for which no incentive stimulus was introduced and no improvement made in discrimination.

TABLE 7.

AVERAGE TIME OF EACH FIVE TRIALS AS A PERCENTAGE OF THE AVERAGE OF THE FIFTY PRACTICE TRIALS.

Group		*C*	*P*	*R*	*GwP*	*TwP*	*K*
Series of five trials							
	1st	118	124	133	128	102	116
P	2nd	112	105	114	117	105	113
R	3rd	101	115	111	114	103	107
A	4th	96	97	108	109	106	99
C	5th	101	98	104	99	95	100
T	6th	90	92	86	85	98	91
I	7th	95	101	89	94	96	95
C	8th	95	93	90	91	96	94
E	9th	93	95	91	85	95	91
	10th	84	88	86	81	92	94
I	1st	95	89	92	84	97	89
N	2nd	85	93	82	108	96	100
C	3rd	90	93	80	106	104	95
E	4th	93	92	76	109	100	93
N	5th	93	94	72	102	105	93
T	6th	88	89	70	97	106	97
I	7th	88	87	72	98	108	93
V	8th	81	80	74	91	109	98
E	9th	73	81	83	91	104	96
	10th	75	76	69	87	106	93

The Guess-with-Punishment and the Told-with-Punishment Groups, in both of which some factors, in the nature of knowledge of direction of error, were introduced in addition to punishment, made slightly greater improvement in discrimination than did the pure Punishment and Reward Groups. These two groups were also the ones in which the presumably normal tendency to gradual decrease of the time per trial was interrupted. Besides receiving punishment, it was made certain that the subjects in these groups would pay particular attention to the direction of their errors. In the Guess-with-Punishment Group, the introduction of the additional factor slowed the time considerably; but the gradual decrease set in again. But in the Told-with-Punishment Group, the effect on the time was to slow it gradually.

Directing the subject's attention to the direction of his errors seemed to cause him to take more time, but brought scarcely any greater improvement in discrimination, and that only when used in addition to punishment, and not when used alone, as in the case of the Knowledge Group.

In view of the above facts and discussion, there is but one safe conclusion: that the time of making a discrimination does not bear any consistent relation to the accuracy of the discrimination; or that some factors which make for improvement in accuracy tend to increase the time, while others do not. Any attempt to read into the data specific relationships between improvement and time is purely speculative. Thus another possible hypothesis to explain the effect of incentives is ruled out.

c. Guess-with-Punishment Group

When considering the improvement made in discrimination, it is natural to wonder if the subjects could, and if they did, guess the direction of their errors, upon the receipt of punishment, or reward, i.e., when the bell rang. The Guess-with-Punishment Group was introduced in the hope of throwing light on this question. It will be recalled that the procedure with this group was identical with that for the Punishment Group, the bell ringing after each error, except for the added requirement that each time the bell rang the subject must guess the direction of his error.

Out of the total number of guesses as to direction of error, the group averaged 70% correct guesses, with the range of individual subjects running from 57% to 89%.

With the right guesses amounting to 70% of the total number of guesses, we note that the subjects were able to do better at guessing the direction of their errors than chance factors alone would warrant, but that they were far from being able to tell with certainty.

If knowing the direction of the error is one of the chief cues through which the improvement is made, it might be expected that even 70% accuracy in guessing would be sufficient to account for the improvement; but there are two indicators in another direction: (1) a comparison of accuracy in guessing with decrease in average error by individuals; (2) the Told-with-Punishment Group.

If the individuals in the Guess-with-Punishment Group are ranked according to amount of improvement made in discrimination, and ranked again according to their accuracy in guessing the direction of their errors, the rank difference correlation is —.18. Such a coefficient indicates that those individuals making the best guesses as to the direction of their errors did not tend to make the most improvement in discrimination.

d. Told-with-Punishment Group

Another answer to this question was sought with the Told-with-Punishment Group. If knowing the direction of the error is one of the chief cues with the aid of which the improvement is made, it might be expected that greater improvement would result if the subject always knew the direction of his error. Hence, this group was given exactly the same conditions as the Punishment Group, but in addition the experimenter said "long" or "short" each time after the bell had rung, thus insuring that the subject knew the direction of his error.

It has been noted that this group reduced its average error to 20% of the average error made on its practice series, and that this is only slightly, and not at all reliably, better than the performance of the group which received punishment alone. And neither can the improvement effected in this group be considered as different from that effected in the Guess-with-Punishment Group.

Since the Guess-with-Punishment Group shows that subjects were able to guess the direction of their errors only 70% of the time, it would be expected that complete knowledge as to the direction of the error would bring about greater improvement in discrimination, providing that this is one of the chief cues employed in decreasing the average error. But since the improvement of the Told-with-Punishment Group was not greater than that of either the Guess-with-Punishment Group or the Punishment Group, we can but conclude against the likelihood that guessing the direction of the error was an important cue in the bringing about of the improvement.

e. Knowledge Group

The Knowledge Group brings out some interesting relationships. The incentive or second day's series for this group was as follows. After each trial the experimenter said, simply "long," "short," or "right," whichever happened to be the case. Thus, this group always knew the direction of its error. In fact, all of the additional factors present for the Told-with-Punishment Group were present here, but the bell was absent. Or again, it might be said that the factors of knowledge concerning the performance were present, but that there was nothing to bring in the nature of punishment or reward, that is no qualitative implications were present in the knowledge, just a matter-of-fact statement of long, short, or right.

While the Knowledge Group receives all of the information concerning its performance that is received by the Told-with-Punishment Group, but does not have the bell, it receives more knowledge concerning its performance than do the Punishment and the Reward Groups. The Punishment and the Reward Groups receive only the bell, and so do not receive any information concerning the direction of their errors.

The striking fact is that while the results for the Knowledge Group show improvement, its improvement is nearly reliably less than that made by the Punishment and the Reward Groups, and is distinctly reliably less than that made by the Guess-wtih-Punishment and the Told-with-Punishment Groups. Thus, the bell, that is incentive in the nature of reward or punishment, is far more effective than even more accurate knowledge concerning the performance.

This is in agreement with the results of Johanson,[10] who found that mere knowledge as to performance, while effective, was not as effective as an incentive stimulus which very definitely consisted in something to be avoided—electric shock. This is what we would call incentive in the nature of punishment.

It would seem that the "second" response which the subject makes to the physical stimuli, in reacting to them as something to be avoided or to be sought after, namely the punishment or the reward, facilitates the performance of the task at hand far more than simple facts about the performance. It follows that the individual must be responding to more cues, or perhaps more adequate cues, in the situation, than he does without the added factor of punishment or reward. But it would seem from this study, that the special cues given more attention, or made more effective, in the case of discriminating lengths, is not the knowledge of the direction of the error.

4. The Variation in Performance Among the Groups During the First Five Trials of the Second Day

The average performance of each subject during the fifty trials of the first day, during which no incentive stimuli were introduced, was used as a base against which to measure the change in performance effected by the introduction of the incentive stimuli on the second day. The performance of each subject during any series of five trials was always considered as a percentage of this base. This seems to be the most suitable measure to use as a base, since it is derived from the greatest number of trials made without an incentive stimulus and so is probably the best measure of the subject's normal performance.

However, the first five trials of the second day were given before the incentive stimuli were introduced, to permit the subject to regain his general orientation toward the task at hand. If the average performance during the fifty trials of the first day is a good index of the subject's normal performance, it might be expected that the performance on this first series of the second day would not vary much from it. Examination of Table 2, which presents the group index of each series of five trials as a percentage of the average of the fifty trials of the first day, reveals that while four of the groups did not vary particularly from their average performance of the first day, the Reward and Guess-with-Punishment Groups made average errors of only 79% and 75%, respectively, of their average errors of their fifty trials of the first day. Two questions naturally arise. First: Is the variation shown by these two groups greater than the chance variation which might be expected from day to day? Second: Is not the effect of the incentive stimuli employed in these two groups being overstated, since during the second day the average errors made by the R Group were actually reduced from only 79% to 26% of the average errors of the first day, and in the case of the GwP Group from only 75% to 15%, instead of from approximately 100% as in the case of all the other groups?

In order to throw some light on these questions and to safeguard any conclusions which might be drawn from the experiment, the data have been recalculated using the average error of the first five trials of the second day as the base. In Table 36, found on page 38 in the appendix, is shown the average error of the last five trials of each subject as a percentage of the average error of his first five trials of the second day. A summary of these by groups is found in Table 3A, below.

TABLE 3A

AVERAGE ERROR OF THE LAST FIVE TRIALS OF THE INCENTIVE SERIES AS A PERCENTAGE OF THE AVERAGE OF THE FIRST FIVE TRIALS OF THE INCENTIVE SERIES.

Group	*C*	*P*	*R*	*GwP*	*TwP*	*K*
Percentage	155	24	36	25	25	60

The reliability of the differences between the groups is shown in Table 4A, below.

TABLE 4A

RELIABILITY OF THE DIFFERENCES BETWEEN THE EFFECTS OF THE DIFFERENT INCENTIVES, AS MEASURED BY THE AVERAGE ERROR OF THE LAST FIVE TRIALS AS A PERCENTAGE OF THE AVERAGE OF THE FIRST FIVE TRIALS OF THE INCENTIVE SERIES

Groups	*Diff.*	*Sigma Diff.*	*Diff.* / *Sigma Diff.*
C and P	131	24.0	5.5
C and R	119	24.6	4.8
C and GwP	130	23.8	5.5
C and TwP	130	24.4	5.3
C and K	95	27.5	3.5
P and R	12	8.5	1.4
P and GwP	1	5.6	0.2
P and TwP	1	7.8	0.1
P and K	36	15.0	2.4
R and GwP	11	7.7	1.4
R and TwP	11	9.5	1.2
R and K	24	15.9	1.5
GwP and TwP	0	7.1	0.0
GwP and K	35	14.6	2.4
TwP and K	35	15.6	2.2

Comparison of Tables 3 and 3A, and of Tables 4 and 4A, reveals that the use of the first five trials of the second day as a base against which to measure change effected by the incentives, instead of the average of the fifty trials of the first day, does not affect the relationships between the performances of the various groups. The only noteworthy change brought about by the use of the new point of reference is that the differences between the K Group and each of the other incentive groups are not so reliable. But this change is not sufficiently marked to affect any of the interpretations or conclusions.

V. EFFECT OF INCENTIVES ON MAKING ONE LINE EQUAL TO ANOTHER

In view of the fact that earlier work on the visual discrimination of length, which has been performed in the interest of the determination of difference thresholds, or in the study of psychophysical methods, has for the most part consisted in the setting of one length equal to another, we present here the results of an earlier experiment performed by the writer,[7] in which incentive stimuli similar to those described above were employed when the task required of the subject was to set one length *equal* to an exposed standard.

The experimental set-up was like that described in Section II above, except that, in place of an illuminated glass bar in a dark room, a standard Galton Bar was used under ordinary conditions of illumination, and no time records were taken. The procedure and the incentive stimuli employed were the same, except that forty-five instead of fifty trials were made on each of the two days of the experiment, and that the subject's task was to set the length on the right of the dividing line *equal* to the 200 mm. length which was exposed as a standard on the left. The distance of the eyes from the bar was 1830 mm.

Three groups of five subjects each were used, consisting in a Control Group, a Punishment Group, and a Reward Group. The results of this experiment are summarized in Table 8, in a form comparable to Tables 2 and 3.

TABLE 8.

Average Error of the Last Five Trials of the Incentive Series as a Percentage of the Average of the Forty-Five Practice Trials.

Group	*Subjects*				
Control	L.C.	J.E.	T.F.	O.K.	A.J.
	86	178	91	95	189
Punishment	J.N.	J.J.	E.H.	A.R.	S.B.
	18	48	115	22	24
Reward	A.H.	R.H.	M.M.	L.G.	M.T.
	30	11	6	33	26

During the extent of the experiment, three subjects of the Control Group, as compared with those of the other two groups made a very small decrease in their average errors, and in the case of two subjects, J.E. and A.J., the average errors showed a marked increase. But when the bell rang after each failure, as in the case of the Punishment Group, marked improvement resulted, except in the case of E.H., upon whom the incentive stimulus seemed to have no effect. The average errors of the other four subjects were brought down to from 18 to 48% of the average errors made by them during their practice trials. When the bell rang after each success, as in the case of the Reward Group, marked improvement resulted on the part of all the subjects. The average errors of their last five trials ranged from 6 to 33% of the average errors of their forty-five practice trials.

Thus we find these two conditions of incentive bringing about marked improvement in the visual discrimination of length, as compared with the change in performance during the same number of trials without incentive stimuli, when the task was that of making one length *equal* to another.

In the light of the previous work of this sort, it is of interest to compare the accuracy attained by these three groups, by considering the value of the average error in relation to the length of the standard. This comparison is made in Table 9.

TABLE 9

Average Error of the Last Five Trials of the Incentive Series as a Percentage of the Standard Length.

Group	*Subjects*				
Control	L.C.	J.E.	T.F.	O.K.	A.J.
	4.6	8.2	4.1	2.1	7.2
Punishment	J.N.	J.J.	E.H.	A.R.	S.B.
	0.9	1.9	8.2	0.8	1.0
Reward	A.H.	R.H.	M.M.	L.G.	M.T.
	1.1	0.5	0.35	0.8	1.4

In the same general way that the results of the previous investigations of the visual discrimination of horizontal lengths by the method of average error have been compared with one another in Table 1, the data of Table 9 may be compared with that of Table 1. That is, one must bear in mind the variations in apparatus and other conditions of the experiments, which render impossible any real comparison. We note that in the case of the individuals reported in Table 1 the relationship of the average error to the standard length, 200 mm., ranges from 0.65 to 3.38%, while the performance of the five individuals in the Control Group (without incentive) in Table 9 ranges from 2.1 to 8.2%. In the case of the individuals who received incentive the range is from 0.35 to 1.9%, exclusive of E.H. who was not affected by the incentive stimulus. The greater error made by the subjects working without incentive than made by the earlier investigators is doubtless due to the differences in the conditions of the experiments. A very striking one is the difference in the distance from the eyes to the lengths being judged, which is from 2¼ to 6 times as great as those used in the other studies. In view of the relationships just pointed out, the relative errors made by the subjects who received incentive may be considered very small indeed, two of them being smaller in absolute difference from any in Table 1, while all are smaller than the relative error of five of the individuals whose work is reported in the latter table. Another difference in conditions of experimentation is that all of the earlier investigators made half of their trials with the comparison distance to the right and half to the left of the standard, while the individuals of Table 9 made all of their trials with the comparison distance to the right of the standard. However, the summary tables of Volkmann and of Appel (see 4) show that while the position of the standard affects the constant error, it has no effect upon the average error.

The subjects in the writer's control groups, who received no incentive stimuli, made no improvement with practice. This is true both of the task of making the comparison length twice as long as the standard, as shown in Table 12, and of the task of making the comparison length equal to the standard, as is shown in Table 10. It would be interesting if we could compare these data with those of other investigators. Only one, however, presents any data which bear upon this point, the others giving only their final summary tables. Kiesow[12] gives us the average error of each twenty of the hundred trials made by his subject. Table 11 shows these figures when the standard length was 200 mm. He also obtained no improvement with practice.

TABLE 10.

CONTROL GROUP.
WHEN TASK WAS TO ADJUST ONE LENGTH EQUAL TO A 200 MM. STANDARD.
THE RESULTS OF TWO DAYS PRACTICE WITHOUT INCENTIVE.
AVERAGE ERROR........IN MM.

Subject		*L.C.*	*J.E.*	*T.F.*	*O.K.*	*A.J.*
Series of five trials						
	1st	19.4	5.4	15.6	4.0	11.6
P	2nd	12.6	9.0	9.8	2.0	7.8
R	3rd	9.4	10.4	8.6	4.4	7.4
A	4th	9.0	9.6	8.8	4.0	5.2
C	5th	10.6	7.2	9.0	3.8	6.6
T	6th	5.0	5.2	9.6	5.6	3.8
I	7th	8.8	5.8	6.8	5.4	6.6
C	8th	12.2	15.6	4.4	4.0	10.2
E	9th	9.6	15.0	8.4	6.4	9.2
	1st	14.8	5.0	8.8	6.0	10.8
C	2nd	7.4	5.8	6.0	4.2	11.2
O	3rd	8.2	6.8	8.4	4.4	11.8
N	4th	6.4	15.0	8.6	4.2	10.0
T	5th	9.2	19.4	8.4	3.8	10.8
R	6th	9.2	17.8	8.6	6.4	10.8
O	7th	8.2	21.0	8.2	4.8	18.2
L	8th	7.2	17.8	6.8	3.2	16.0
	9th	9.2	16.4	8.2	4.2	14.4

TABLE 11.

TABLE FROM KIESOW SHOWING THE AVERAGE ERROR OF EACH TWENTY TRIALS WHEN THE STANDARD LENGTH WAS 200 MM.

1st 20 trials	1.275
2nd 20 trials	1.335
3rd 20 trials	1.33
4th 20 trials	1.26
5th 20 trials	1.33

VI. SUMMARY AND CONCLUSIONS

1. Mere continued repetition of this simple discrimination brought practically no change in accuracy.

2. Incentive stimuli effected improvement in accuracy in the discrimination of length, in the task of making one line equal to a standard, and of making it twice the length of a standard.

3. Under the conditions of incentive as described, visual discrimination of horizontal lengths by the method of average error was brought to a point of greater accuracy than had heretofore been attained.

4. The attitudes of reward and punishment created by our incentive stimuli were not reliably different in their effectiveness.

5. The physical stimuli used in creating the incentives do not in themselves constitute the incentives, for one and the same stimulus may at different times act as a quite different incentive. The incentive itself, then, may be an interpretation placed upon the stimulus by the subject, or a part of the subject's reaction to the stimulus, and so would depend upon the conditions under which the physical stimulus is given.

6. The experiment would indicate that in effecting improvement in discrimination of length the constant error is decreased first, even though no indication of the direction of the error is given; and is later followed, if the improvement is carried far enough, by decrease in variability, or variable error.

7. The time consumed in making a discrimination did not bear a consistent relationship to the accuracy of the discrimination.

8. Upon being informed that an error had been made, subjects were fairly well able to guess its direction; but this ability did not seem to play an important part in bringing about improvement.

9. Definite knowledge as to direction of error when given along with the punishment attitude did not effect more improvement than the reward or punishment attitude alone.

10. Definite knowledge when given in the absence of the reward or punishment attitude did not effect as much improvement as either of these attitudes when given without such knowledge.

11. The emotional nature of the reward or of the punishment attitude seemed to serve to heighten the attention to the task at hand, and perhaps enabled the subject to employ cues not otherwise brought into play.

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VIII. APPENDIX

TABLE 12

CONTROL GROUP

AVERAGE ERROR........IN MM.

Subject		*H.Q.*	*S.O.*	*I.L.*	*V.K.*	*I.R.*	*B.E.*	*H.A.K.*	*M.R.*	*M.M.S.*	*C.G.*
Series of five trials	1st	13.4	15.2	7.2	23.3	46.6	7.4	19.6	32.4	12.8	22.6
P	2nd	20.8	5.8	46.4	37.0	30.8	5.4	10.8	17.8	7.4	6.4
R	3rd	17.6	6.4	14.2	36.4	15.2	7.8	8.8	11.8	8.4	12.2
A	4th	10 2	12.2	29.6	33.6	15.6	5.2	15.4	8.6	12.2	21.0
C	5th	14.4	9.8	11.8	37.8	20.8	8.2	7.6	9.6	5.2	12.4
T	6th	16.2	12.6	12.2	35.2	10.0	10.4	9.8	8.0	6.2	17.0
I	7th	12.0	10.2	29.0	39.6	12.2	9.6	8.8	21.0	8.6	10.0
C	8th	15.2	9.6	22.0	23.0	11.2	13.2	14.0	6.6	16.0	12.6
E	9th	22.6	11.8	16.4	25.4	15.2	13.0	10.8	11.6	14.8	13.4
	10th	15.6	9.6	22.4	23.0	13.0	25.6	17.8	11.8	9.0	11.6
	1st	15.2	10.6	9.8	31.6	8.0	10.6	32.4	12.0	13.4	7.2
	2nd	16.8	7.4	11.2	26.0	9.8	4.6	15.6	7.0	16.0	13.8
C	3rd	30.0	7.2	18.4	31.6	8.2	16.0	7.6	8.0	6.0	12.8
O	4th	31.4	13.4	26.0	25.6	8.6	3.8	18.0	12.6	6.2	7.0
N	5th	32.2	10.0	18.8	23.0	11.0	14.2	15.4	8.2	9.6	26.6
T	6th	37.2	10.0	17.0	23.4	13.6	14.0	17.4	8.4	10.6	23.8
R	7th	28.8	12.2	22.8	34.0	10.8	11.4	7.0	11.0	9.2	19.6
O	8th	30.0	11.2	10.2	17.6	12.6	13.0	7.2	12.8	10.2	22.8
L	9th	37.4	10.8	17.8	25.6	19.2	16.8	10.2	10.6	13.8	13.0
	10th	33.0	11.8	26.6	28.2	16.4	10.6	10.6	11.8	24.6	17.4
Average Fifty Practice Trials		15.8	10.3	20.4	31.4	19.1	10.6	12.3	13.9	10.1	13.9
Group Average for Fifty Practice Trials			15.8								

TABLE 13

PUNISHMENT GROUP

AVERAGE ERROR........IN MM.

Subject		*I.T.*	*F.K.*	*M.W.S.*	*D.H.*	*F.Gr.*	*E.M.H.*	*H.R.K.*	*D.G.*	*V.L.*	*M.M.*
Series of five trials	1st	53.0	11.2	86.4	11.6	14.2	13.4	30.0	18.2	33.0	51.8
P	2nd	13.2	10.6	84.4	19.0	5.8	11.8	28.0	14.2	15.6	9.4
R	3rd	13.4	5.6	77.4	9.0	5.6	26.2	7.2	12.2	8.2	17.8
A	4th	5.0	7.8	93.6	39.6	14.0	10.8	11.0	13.6	9.6	24.6
C	5th	14.8	12.4	67.6	11.6	5.6	7.0	8.2	10.8	8.4	20.8
T	6th	11.0	18.2	91.0	28.6	20.0	4.6	16.8	4.8	6.6	35.4
I	7th	6.4	19.6	66.6	10.8	6.8	16.4	14.2	12.8	12.6	19.8
C	8th	8.6	19.8	86.2	29.0	8.6	10.8	10.0	10.8	14.6	32.2
E	9th	15.8	11.2	88.0	25.2	5.8	11.0	10.0	10.6	14.2	16.0
	10th	13.6	15.4	89.0	19.0	13.2	9.0	7.4	19.2	12.0	21.8
P	1st	19.0	23.8	71.4	35.0	11.6	14.2	7.8	10.4	10.4	16.2
U	2nd	9.0	22.4	53.8	21.6	11.2	5.8	7.8	16.0	8.8	10.8
N	3rd	13.8	17.0	23.6	11.4	8.2	7.8	33.0	8.6	5.2	9.0
I	4th	7.4	7.8	14.8	14.8	4.6	8.6	21.8	19.0	5.4	13.0
S	5th	13.6	9.0	14.0	14.8	7.2	3.6	23.2	4.4	4.8	5.0
H	6th	9.4	21.4	6.0	15.0	7.4	5.6	9.6	4.8	10.2	5.4
M	7th	7.4	8.4	16.8	13.2	3.4	5.6	6.4	7.8	9.0	4.6
E	8th	12.2	5.2	5.0	8.4	3.8	1.8	4.8	5.8	8.0	5.0
N	9th	8.8	8.2	8.8	8.4	5.2	8.8	6.4	2.4	4.8	5.9
T	10th	4.4	4.6	3.0	6.4	4.2	2.0	4.4	2.2	4.0	1.4
Average Fifty Practice Trials		15.5	13.2	83.0	20.3	10.0	12.1	14.3	12.7	13.5	25.0
Group Average for Fifty Practice Trials			22.0								

TABLE 14

Reward Group

Average Error........in mm.

Subject		*C.L.*	*H.P.*	*J.Pi.*	*H.U.*	*E.Wa*	*H.R.*	*C.T.*	*V.F.*	*H.S.*	*S.R.*
Series of five trials	1st	10.6	10.4	14.0	22.4	28.6	6.2	50.8	18.4	30.0	27.2
P	2nd	13.2	15.2	4.2	11.8	20.6	6.4	29.2	10.4	26.6	9.8
R	3rd	7.0	14.4	12.0	20.8	6.8	11.4	11.8	14.4	25.6	11.0
A	4th	18.0	9.4	4.4	27.8	9.0	9.2	10.8	12.2	21.8	12.2
C	5th	8.4	12.2	6.4	14.2	7.2	5.8	9.4	13.4	20.6	17.8
T	6th	10.4	8.0	4.2	12.2	10.4	6.2	19.8	13.2	15.8	8.8
I	7th	17.0	10.6	11.4	18.4	8.0	7.4	17.0	13.4	14.4	13.4
C	8th	12.4	15.4	13.2	21.0	20.8	14.6	5.8	21.4	10.8	10.6
E	9th	11.2	19.6	9.0	15.4	15.2	15.4	15.2	10.6	17.6	12.8
	10th	15.4	14.0	9.2	18.0	12.6	10.2	13.6	22.4	12.0	22.2
	1st	8.6	10.8	6.4	15.2	5.8	13.0	7.8	8.4	25.0	10.8
	2nd	9.0	10.8	14.2	11.0	13.2	18.2	19.4	14.4	12.2	5.6
R	3rd	4.0	6.4	6.4	10.0	7.8	22.0	16.6	6.4	10.4	4.2
E	4th	7.8	10.4	9.4	6.0	15.2	21.8	5.6	5.6	3.0	11.8
W	5th	10.8	7.4	2.4	2.8	14.6	19.0	12.0	6.4	8.6	3.0
A	6th	13.8	9.2	1.4	6.6	7.8	20.0	21.0	9.0	4.6	7.6
R	7th	10.6	6.0	2.2	10.2	16.2	15.8	9.8	12.8	3.4	3.2
D	8th	9.8	6.4	2.2	5.8	7.6	9.4	5.0	9.6	6.6	11.4
	9th	7.4	5.0	0.8	3.0	6.8	6.8	6.6	3.4	4.6	5.8
	10th	4.8	3.8	1.0	2.8	5.2	5.4	3.2	3.2	2.8	2.0
Average Fifty Practice Trials		12.4	12.9	8.8	18.2	13.9	9.3	18.3	15.0	19.5	14.6
Group Average for Fifty Practice Trials			14.3								

TABLE 15

GUESS-WITH-PUNISHMENT GROUP

AVERAGE ERROR........IN MM.

Subject		*E.Be*	*I.B.*	*L.R.*	*B.M.*	*S.S.*	*L.L.*	*H.B.*	*F.Ga*	*V.C.*	*A.G.*
Series of five trials	1st	20.8	43.8	29.6	25.6	43.6	28.8	12.6	14.6	32.2	12.0
P	2nd	14.2	16.0	26.6	9.0	26.0	14.6	17.8	18.2	20.8	21.2
R	3rd	12.4	32.4	24.4	11.8	45.8	15.8	9.6	15.0	15.4	39.2
A	4th	11.4	28.2	18.4	4.0	37.4	10.8	8.8	19.0	10.4	33.6
C	5th	29.2	21.2	26.8	7.4	42.2	20.2	20.0	9.2	3.6	23.0
T	6th	24.0	14.8	24.0	6.6	36.8	17.8	27.2	10.4	7.2	36.2
I	7th	20.0	37.8	25.9	14.6	28.0	12.4	9.4	31.6	6.4	20.0
C	8th	34.2	29.0	16.6	14.8	32.4	21.6	8.2	9.0	8.2	23.4
E	9th	31.2	17.6	19.2	10.2	41.2	22.8	14.4	15.0	11.2	23.6
	10th	24.6	20.0	22.8	11.8	29.8	15.2	10.0	15.8	4.4	20.8
P	1st	26.0	15.6	35.0	13.6	5.2	14.2	9.0	9.2	4.6	12.0
U	2nd	22.6	10.8	31.2	14.6	8.2	6.2	3.6	14.2	10.4	9.2
G w N	3rd	21.8	23.0	26.8	9.2	5.6	4.8	7.8	19.4	3.4	8.2
U i I	4th	6.0	8.6	15.2	10.8	24.0	8.4	11.2	21.6	12.8	9.8
E t S	5th	7.8	21.4	20.0	10.6	11.8	5.0	23.0	6.2	13.2	5.8
S h H	6th	9.0	12.6	9.4	4.2	4.2	2.8	16.0	13.6	2.6	11.0
S M	7th	5.8	11.4	10.0	3.8	8.2	9.8	3.0	5.2	19.6	13.4
E	8th	8.2	9.2	12.0	9.8	2.4	4.6	9.8	11.8	7.4	3.4
N	9th	4.2	6.8	10.8	9.6	11.0	2.8	3.2	9.4	6.8	6.8
T	10th	3.4	5.4	4.2	2.4	2.0	2.2	2.8	2.4	1.8	2.8
Average Fifty Practice Trials		22.2	26.1	23.4	11.6	36.3	18.0	13.8	15.8	12.0	25.3
Group Practice for Fifty Practice Trials			20.5								

TABLE 16

Told-with-Punishment Group

Average Error........in mm.

Subject		M.I.	E.G.	E.Re	J.Po	E.We	I.M.	E.S.	E.Ro	M.C.S.	B.C.
Series of five trials	1st	41.4	12.0	20.8	25.4	37.2	23.2	30.8	27.0	27.6	14.0
P	2nd	21.4	5.2	11.0	20.6	14.8	29.4	20.6	7.8	9.2	10.6
R	3rd	15.0	8.0	3.0	10.6	9.4	9.4	13.0	16.8	10.8	15.6
A	4th	11.4	14.8	7.6	17.0	16.2	11.0	14.0	22.8	3.2	13.4
C	5th	11.8	5.6	6.8	9.4	26.2	11.4	15.4	15.0	7.0	10.4
T	6th	3.6	8.8	5.0	19.0	20.4	21.0	10.2	15.4	9.0	25.4
I	7th	15.6	13.6	10.8	13.2	15.4	18.0	12.8	17.0	10.8	15.8
C	8th	5.6	4.2	8.6	10.0	8.6	17.4	10.8	14.8	9.6	8.4
E	9th	5.8	5.8	4.6	11.6	10.6	12.6	12.2	18.8	11.4	11.0
	10th	8.0	9.6	5.6	14.8	22.0	11.0	11.8	14.8	7.2	21.8
P	1st	11.4	17.4	15.2	8.6	17.0	4.0	15.2	21.4	10.2	10.2
U	2nd	5.0	9.6	5.0	10.2	6.8	18.4	15.6	12.6	10.6	9.8
N	3rd	16.0	7.2	7.6	7.6	14.6	11.4	9.6	13.6	13.6	9.8
T w I	4th	8.0	6.8	8.8	4.0	4.0	13.4	5.4	6.6	8.6	8.8
O i S	5th	10.6	10.2	4.0	9.4	6.2	12.0	7.0	10.4	8.2	9.0
L t H	6th	7.2	5.0	2.0	4.0	5.2	5.6	4.2	6.8	4.4	8.0
D h M	7th	1.6	4.0	3.8	2.6	6.2	11.4	11.2	3.4	8.6	4.4
E	8th	7.2	3.2	3.0	1.0	5.4	5.0	6.8	9.2	4.8	7.4
N	9th	8.6	4.8	2.8	2.8	3.4	4.0	3.8	4.2	3.4	2.8
T	10th	1.8	3.2	1.4	1.2	2.6	3.2	3.8	2.0	3.6	3.2
Average Fifty Practice Trials		14.0	8.8	8.4	15.2	18.1	16.4	15.2	17.0	10.6	14.6
Group Average for Fifty Practice Trials			13.8								

TABLE 17

KNOWLEDGE GROUP

AVERAGE ERROR........IN MM.

Subject		*M.K.*	*E.V.*	*L.W.*	*E.H.H.*	*P.H.*	*E.M.*	*J.F.*	*E.Bj*	*M.J.*	*T.L.*
Series of five trials	1st	22.6	13.8	8.0	8.8	16.4	34.6	4.0	12.0	24.2	11.8
P	2nd	23.4	25.4	23.2	10.4	10.4	24.4	19.4	9.2	5.2	8.0
R	3rd	12.6	35.6	11.0	9.4	3.4	36.0	19.2	16.6	11.2	8.8
A	4th	9.4	63.4	24.2	8.2	6.0	13.6	14.2	9.6	7.6	7.4
C	5th	7.0	41.0	23.0	21.2	6.6	31.4	10.2	10.4	14.8	9.6
T	6th	11.8	83.2	16.8	15.4	12.8	25.4	13.0	16.8	9.4	7.6
I	7th	8.8	58.8	11.6	6.4	10.2	19.6	17.6	4.4	6.0	7.8
C	8th	12.4	64.2	19.0	9.8	21.2	27.2	16.6	9.0	10.0	9.0
E	9th	7.6	41.0	26.6	10.0	7.6	8.6	21.8	7.8	18.2	7.4
	10th	11.8	39.2	11.0	26.4	24.8	9.4	21.6	12.6	7.0	16.2
K	1st	11.6	37.0	11.4	26.0	17.4	16.4	5.6	13.6	12.0	5.4
N	2nd	8.6	20.4	11.8	12.4	7.4	18.6	6.4	16.0	4.8	5.6
O	3rd	7.6	25.6	5.8	10.8	8.0	7.8	14.0	9.8	10.6	9.6
W	4th	9.6	31.0	11.2	3.2	11.4	20.0	10.0	11.2	7.4	11.6
L	5th	9.8	16.4	3.0	8.2	10.0	6.2	5.4	8.4	11.4	5.4
E	6th	6.8	13.2	7.2	9.0	7.0	15.2	7.0	8.0	9.6	4.6
D	7th	5.2	9.6	7.2	4.2	5.6	6.8	4.4	6.8	4.6	3.2
G	8th	10.4	10.2	3.8	5.6	8.8	11.0	7.0	6.4	4.4	11.6
E	9th	9.8	17.6	1.4	6.4	11.0	9.2	10.4	7.6	4.2	5.2
	10th	5.6	6.6	4.4	2.8	6.6	7.6	9.6	6.2	9.4	5.6
Average Fifty Practice Trials		12.7	46.6	17.4	12.6	11.9	23.0	15.8	10.8	11.4	9.4
Group Average for Fifty Practice Trials			17.2								

TABLE 18.

CONTROL GROUP

CONSTANT ERROR........IN MM.

Subject		*H.Q.*	*S.O.*	*I.L.*	*V.K.*	*I.R.*	*B.E.*	*H.A.K.*	*M.R.*	*M.M.S.*	*C.G.*
Series of five trials											
PRACTICE	2nd, 3rd, 4th	—17.1	+3.1	+26.9	—35.6	—19.2	— 1.2	+ 7.7	—10.1	+ 7.2	+ 9.6
	5th, 6th, 7th	—14.2	+4.9	+14.7	—38.2	—11.1	— 9.4	+ 8.1	+ 7.0	+ 1.9	+13.1
	8th, 9th, 10th	—17.8	+5.1	+13.5	—23.8	+ 1.9	—16.7	+10.2	— .4	+11.1	+ 9.9
CONTROL	2nd, 3rd, 4th	—25.8	+1.9	+18.5	—27.7	— 7.1	— 6.7	+10.0	— .3	+ 8.6	+ 8.3
	5th, 6th, 7th	—32.1	+3.7	+18.5	—26.1	+ 9.1	—13.2	+11.7	+ 8.9	+ 9.3	+22.4
	8th, 9th, 10th	—32.1	+2.9	+ 6.1	—18.2	— 5.3	—13.8	+ 6.5	+ 9.1	+16.2	+17.7

TABLE 19.

PUNISHMENT GROUP

CONSTANT ERROR........IN MM.

Subject	Series of five trials	*I.T.*	*F.K.*	*M.W.S.*	*D.H.*	*F.Gr*	*E.M.H.*	*H.R.K.*	*D.G.*	*V.L.*	*M.M.*
PRACTICE	2nd, 3rd, 4th	— 8.9	— 4.5	+85.5	+18.9	+ .6	—11.7	+ 9.9	—8.3	—1.5	+15.9
	5th, 6th, 7th	+ 3.0	+15.1	+81.1	+ 8.5	+ 4.4	— 8.8	+ 7.3	+ .1	—8.5	+25.2
	8th, 9th, 10th	—10.5	+12.0	+87.7	+23.6	+10.0	— 8.1	+ 6.1	—8.9	+6.5	+22.0
PUNISHMENT	2nd, 3rd, 4th	+ 6.3	+10.5	+27.1	+ 8.2	— 4.1	— .1	+15.9	—4.4	—1.8	+ 8.4
	5th, 6th, 7th	+10.1	+ 9.9	+ 6.1	+ .3	0.0	— 3.2	+ 9.2	—3.0	—2.1	— .3
	8th, 9th, 10th	+ 1.5	— .4	+ .1	+ 6.9	— 3.7	— 1.9	— 4.9	— .5	+ .4	+ 3.5

TABLE 20.

Reward Group

Constant Error........in mm.

Subject		C.L.	H.P.	J.Pi	H.U.	E.Wa	H.R.	C.T.	V.F.	H.S.	S.R.
Series of five trials											
PRACTICE	2nd, 3rd, 4th	+10.9	+13.1	— .3	+18.5	+ 1.1	— 1.9	—19.1	—11.1	—24.6	—6.3
	5th, 6th, 7th	+ .3	— 8.4	0.0	+14.5	+ 3.6	+ 1.3	+ 6.5	—10.3	—16.9	+ .9
	8th, 9th, 10th	+ 9.8	+ 5.8	+8.9	+17.5	+13.9	—12.2	+10.2	+ 3.1	—11.3	—4.1
REWARD	2nd, 3rd, 4th	— 1.1	+ .3	—5.1	— 8.6	— 3.8	—20.5	+ 7.3	— 5.1	— 8.0	— .9
	5th, 6th, 7th	+ 2.7	+ .5	— .1	+ 2.1	+ 7.1	—18.3	+14.1	+ 7.1	— 1.3	+1.4
	8th, 9th, 10th	+ 6.3	+ .7	+ .8	— 2.1	+ 2.8	— 2.1	+ 1.6	+ 1.8	+ .8	—1.7

TABLE 21.

GUESS-WITH-PUNISHMENT GROUP

CONSTANT ERROR........IN MM.

Subject		*E.Be*	*I.B.*	*L.R.*	*B.M.*	*S.S.*	*L.L.*	*H.B.*	*F.Ga*	*V.C.*	*A.G.*
Series of five trials											
PRACTICE	2nd, 3rd, 4th	— 2.8	—21.1	—22.5	—5.5	—36.4	—13.7	— 7.0	+15.5	—9.5	+31.3
	5th, 6th, 7th	—24.4	—24.6	—25.5	+4.3	—34.3	—16.8	+17.7	+18.4	+2.5	+26.4
	8th, 9th, 10th	—31.3	—24.2	—19.5	—1.6	—34.5	—19.9	+ .3	— 7.7	—2.2	+22.6
GUESS with PUNISHMENT	2nd, 3rd, 4th	—12.8	— 6.0	—24.4	—1.3	+ 4.6	— 6.3	+ 2.7	— 3.2	—5.0	+ 8.9
	5th, 6th, 7th	— .9	— 9.1	—13.1	+5.5	+ 1.4	— 4.9	+ 4.3	+ 2.1	—5.5	+ 7.1
	8th, 9th, 10th	— 2.3	— 4.1	— 6.7	+ .2	+ 4.9	— 2.5	+ 3.7	+ 3.1	—4.4	+ .6

TABLE 22.

Told-with-Punishment Group

Constant Error........in mm.

Subject		*M.I.*	*E.G.*	*E.Re*	*J.Po*	*E.We*	*I.M.*	*E.S.*	*E.Ro*	*M.C.S.*	*B.C.*
Series of five trials PRACTICE	2nd, 3rd, 4th	—14.3	+1.9	—1.9	+15.9	+ 3.3	—16.6	—3.3	—14.5	— .8	+ 7.5
	5th, 6th, 7th	— 5.4	—3.7	+ .7	+11.1	+20.7	— 4.8	—3.9	—14.9	—6.0	+16.8
	8th, 9th, 10th	+ 3.9	— .5	—1.7	+12.1	+10.4	+ 4.3	—3.9	—15.2	—9.0	+ 7.5
TOLD with PUNISHMENT	2nd, 3rd, 4th	— 8.2	— .4	— .6	+ 1.8	+ 4.1	— 3.6	+7.9	— 5.7	— .3	+ 1.1
	5th, 6th, 7th	— 4.6	+4.5	— .3	+ 3.1	+ .5	+ .1	—2.5	— 4.2	—1.7	+ 1.5
	8th, 9th, 10th	— 1.5	+1.2	+ .9	— .1	— .9	+ .5	—3.1	— 2.2	— .7	— .7

TABLE 23.
Knowledge Group
Constant Error........in mm.

Subject		*M.K.*	*E.V.*	*L.W.*	*E.H.H.*	*P.H.*	*E.M.*	*J.F.*	*E.Bj*	*M.J.*	*T.L.*
Series of five trials PRACTICE	2nd, 3rd, 4th	—14.3	+41.5	+17.6	+ 2.5	— 1.8	—23.1	+14.5	+ .3	+3.4	+ 3.1
	5th, 6th, 7th	+ 8.3	+66.5	+16.5	+13.5	+ 7.1	—21.5	+13.5	+10.5	+5.5	— 2.5
	8th, 9th, 10th	— 7.0	+48.1	+11.5	+15.4	+17.5	—14.9	+19.5	+ 9.8	—6.4	+10.9
KNOWLEDGE	2nd, 3rd, 4th	+ .9	+22.2	+ 6.1	+ 1.7	+ 3.6	— 7.2	+ 5.7	+ 8.7	— .3	— 5.6
	5th, 6th, 7th	— 1.9	+12.7	+ 1.9	— 2.6	+ 2.2	+ .9	+ 3.2	+ 5.1	—1.6	+ .1
	8th, 9th, 10th	— 4.2	+ 4.4	+ .4	+ 1.3	+ 1.0	— .3	+ 1.9	+ 1.3	—1.5	— .1

TABLE 24

CONTROL GROUP

VARIABLE ERROR........IN MM.

Subject		*H.Q.*	*S.O.*	*I.L.*	*V.K.*	*I.R.*	*B.E.*	*H.A.K.*	*M.R.*	*M.M.S.*	*C.G.*
Series of five trials											
PRACTICE	2nd, 3rd, 4th	6.2	6.4	8.4	11.5	11.2	5.7	11.0	8.6	7.1	5.8
	5th, 6th, 7th	5.2	6.3	8.7	15.4	10.9	3.4	8.1	9.2	6.2	6.9
	8th, 9th, 10th	5.1	8.2	11.2	9.6	9.7	7.3	12.7	9.0	7.8	8.6
CONTROL	2nd, 3rd, 4th	7.0	9.3	9.7	4.6	6.2	4.0	11.7	9.0	4.7	6.8
	5th, 6th, 7th	7.3	9.3	11.1	12.9	4.6	4.9	9.2	3.2	4.6	7.0
	8th, 9th, 10th	5.1	10.7	12.9	13.4	12.8	5.8	4.6	6.8	5.1	6.5

TABLE 25

PUNISHMENT GROUP

VARIABLE ERROR........IN MM.

Subject		*I.T.*	*F.K.*	*M.W.S.*	*D.H.*	*F.Gr*	*E.M.H.*	*H.R.K.*	*D.G.*	*V.L.*	*M.M.*
Series of five trials											
PRACTICE	2nd, 3rd, 4th	4.7	6.9	6.7	11.5	7.5	9.1	12.2	9.4	6.6	8.1
	5th, 6th, 7th	7.2	10.9	10.1	9.1	8.9	5.2	10.0	8.9	5.1	12.5
	8th, 9th, 10th	6.4	9.1	10.0	13.4	3.9	6.8	7.0	8.8	9.2	9.9
PUNISHMENT	2nd, 3rd, 4th	9.9	5.8	10.8	8.8	7.2	5.9	10.9	9.2	5.3	8.5
	5th, 6th, 7th	4.8	7.0	9.8	13.2	5.0	3.2	9.2	4.7	5.8	5.0
	8th, 9th, 10th	7.1	5.6	5.2	9.0	2.2	2.4	3.0	3.2	5.7	2.4

TABLE 26

REWARD GROUP

VARIABLE ERROR........IN MM.

Subject		C.L.	H.P.	J.Pi	H.U.	E.Wa	H.R.	C.T.	V.F.	H.S.	S.R.
Series of five trials PRACTICE	2nd, 3rd, 4th	6.5	7.4	6.9	7.3	11.8	9.6	6.8	8.8	2.9	7.9
	5th, 6th, 7th	9.9	6.5	6.5	6.8	5.4	6.1	9.8	8.5	7.0	7.9
	8th, 9th, 10th	7.4	6.5	7.9	6.1	11.4	6.0	5.1	9.8	6.1	10.2
REWARD	2nd, 3rd, 4th	7.0	7.8	9.0	5.3	11.1	6.1	13.8	6.4	5.2	5.9
	5th, 6th, 7th	11.5	7.6	2.0	6.6	8.0	6.1	7.1	6.2	4.8	4.1
	8th, 9th, 10th	5.3	3.7	1.1	3.2	6.2	6.9	3.3	4.6	4.0	4.6

TABLE 27

GUESS-WITH-PUNISHMENT GROUP

VARIABLE ERROR........IN MM.

Subjects		*E.Be*	*I.B.*	*L.R.*	*B.M.*	*S.S.*	*L.L.*	*H.B.*	*F.Ga*	*V.C.*	*A.G.*
Series of five trials											
PRACTICE	2nd, 3rd, 4th	10.2	13.9	5.2	6.8	4.9	2.8	7.7	14.4	10.0	8.1
	5th, 6th, 7th	8.3	7.0	4.7	5.8	7.8	4.7	8.3	9.4	3.1	8.9
	8th, 9th, 10th	6.3	14.0	6.9	7.0	8.9	3.7	8.3	4.5	5.8	6.1
GUESS with PUNISHMENT	2nd, 3rd, 4th	6.2	11.9	4.7	9.1	7.4	2.8	6.0	15.9	5.6	4.3
	5th, 6th, 7th	7.9	11.4	4.8	3.2	8.0	3.0	12.9	7.9	8.0	5.5
	8th, 9th, 10th	4.6	6.6	5.5	7.2	2.0	1.7	3.7	7.2	4.6	4.3

TABLE 28

Told-with-Punishment Group

Variable Error........in mm.

Subject		*M.I.*	*E.G.*	*E.Re*	*J.Po*	*E.We*	*I.M.*	*E.S.*	*E.Ro*	*M.C.S.*	*B.C.*
Series of five trials PRACTICE	2nd, 3rd, 4th	9.6	4.8	4.3	11.8	6.2	6.7	10.5	8.2	5.9	11.7
	5th, 6th, 7th	9.1	6.2	6.4	10.2	7.5	8.8	11.4	7.9	7.3	11.0
	8th, 9th, 10th	7.2	5.6	6.2	4.8	7.3	11.2	7.7	8.3	5.3	12.1
TOLD with PUNISHMENT	2nd, 3rd, 4th	7.0	4.7	6.8	7.0	6.9	12.6	5.5	6.4	8.8	6.4
	5th, 6th, 7th	4.7	5.1	2.8	4.0	5.7	7.7	7.2	7.9	6.2	6.8
	8th, 9th, 10th	5.6	3.4	2.1	1.6	3.0	3.2	3.8	4.0	3.5	4.3

TABLE 29

KNOWLEDGE GROUP

VARIABLE ERROR........IN MM.

Subject		*M.K.*	*E.V.*	*L.W.*	*E.H.H.*	*P.H.*	*E.M.*	*J.F.*	*E.Bj*	*M.J.*	*T.L.*
Series of five trials											
PRACTICE	2nd, 3rd, 4th	6.7	8.3	11.0	9.6	9.1	8.2	13.4	6.6	5.3	6.7
	5th, 6th, 7th	5.0	11.2	6.6	6.6	7.3	11.0	7.1	5.1	8.1	6.7
	8th, 9th, 10th	9.5	12.8	12.6	9.2	6.7	5.0	9.4	4.3	9.1	4.8
KNOWLEDGE	2nd, 3rd, 4th	8.3	11.3	7.0	8.8	7.7	10.1	7.0	7.5	7.5	6.2
	5th, 6th, 7th	7.4	7.2	5.5	7.9	6.2	8.3	4.3	4.6	7.8	4.4
	8th, 9th, 10th	7.2	10.1	2.8	4.7	6.9	8.3	7.7	6.3	5.8	6.5

TABLE 30

Control Group

Average Time Per Trial in Seconds for Each Series of Five Trials

Subject		*H.Q.*	*S.O.*	*I.L.*	*V.K.*	*I.R.*	*B.E.*	*H.A.K.*	*M.R.*	*M.M.S.*	*C.G.*	*Average*
Series of five trials	1st	17.4	47.9	23.7	48.8	8.9	25.4	11.0	30.0	33.0	37.0	28.3
P	2nd	22.9	58.5	18.7	47.9	8.3	22.6	8.6	29.0	28.1	25.2	27.0
R	3rd	16.9	50.4	18.9	37.6	8.8	20.7	10.0	24.7	26.3	28.3	24.3
A	4th	18.3	44.2	14.6	....	10.1	25.9	11.9	27.9	26.4	27.7	23.0
C	5th	20.2	56.6	18.5	24.7	8.7	21.2	11.8	27.0	24.7	28.1	24.2
T	6th	23.1	34.0	14.7	22.7	9.3	25.5	11.7	31.1	24.0	19.4	21.6
I	7th	22.5	36.0	17.2	26.6	8.9	29.8	13.3	27.4	21.5	23.5	22.7
C	8th	21.6	43.0	15.2	16.5	9.6	23.5	12.8	43.0	21.1	22.3	22.9
E	9th	19.3	46.1	14.7	....	8.9	23.1	9.5	34.9	21.1	22.4	22.2
	10th	19.8	44.6	16.6	....	8.6	21.4	11.5	....	20.9	17.5	20.1
	1st	24.7	49.0	14.1	24.2	8.3	24.5	7.6	28.8	23.1	22.9	22.7
	2nd	18.3	49.8	14.4	16.8	8.2	16.8	8.7	30.1	20.5	19.3	20.3
C	3rd	27.0	56.7	12.4	16.5	9.1	17.0	7.9	30.7	21.1	16.5	21.5
O	4th	28.5	53.5	14.5	23.0	8.8	20.0	10.4	25.0	19.5	18.3	22.2
N	5th	23.6	61.5	15.0	19.9	8.9	22.2	10.2	26.4	17.3	17.9	22.3
T	6th	28.0	46.6	13.3	20.3	9.7	19.0	9.7	33.6	17.8	14.4	21.2
R	7th	23.5	50.6	12.9	18.2	8.9	14.5	11.0	35.3	20.3	15.5	21.1
O	8th	24.4	44.4	11.5	14.9	9.2	18.5	9.0	27.4	18.5	15.9	19.4
L	9th	18.5	46.3	9.7	18.0	8.8	16.5	9.4	....	15.3	15.7	17.6
	10th	19.6	50.5	8.5	12.4	10.5	18.9	8.9	....	16.8	15.6	18.0
Average Fifty Practice Trials		20.2	46.1	17.3	32.1	9.0	23.9	11.2	30.6	24.7	25.1	24.0

TABLE 31

PUNISHMENT GROUP

AVERAGE TIME PER TRIAL IN SECONDS FOR EACH SERIES OF FIVE TRIALS

Subject		*I.T.*	*F.K.*	*M.W.S.*	*D.H.*	*F.Gr*	*E.M.H.*	*H.R.K.*	*D.G.*	*V.L.*	*M.M.*	*Average*
Series of five trials	1st	29.3	59.0	10.6	27.2	29.6	17.5	12.6	11.7	15.9	19.5	23.3
P	2nd	29.5	43.4	9.0	25.9	23.9	13.6	15.0	9.0	12.9	15.3	19.8
R	3rd	27.1	43.7	....	27.2	27.7	11.9	17.3	10.9	13.6	14.8	21.6
A	4th	27.1	30.0	9.4	24.2	23.0	13.7	16.9	12.8	11.6	14.7	18.3
C	5th	24.7	37.0	6.9	28.1	21.6	9.6	17.9	11.2	12.6	14.0	18.4
T	6th	27.0	31.1	8.3	22.0	21.8	8.9	16.0	12.7	12.8	12.3	17.3
I	7th	24.7	33.5	8.2	26.3	21.1	11.4	17.5	11.6	13.7	10.7	18.9
C	8th	22.3	33.0	8.4	21.2	23.0	11.4	18.2	11.8	12.3	12.1	17.4
E	9th	24.8	36.4	8.4	26.9	16.8	11.9	19.2	11.0	12.0	11.8	17.9
	10th	24.3	32.2	8.4	....	23.2	10.1	16.1	14.0	10.9	9.8	16.6
P	1st	25.0	29.3	8.3	21.5	13.2	12.6	18.9	13.4	11.1	13.6	16.7
U	2nd	27.6	....	8.4	33.0	14.5	14.9	16.4	13.7	11.3	17.1	17.4
N	3rd	26.2	29.5	7.4	20.7	17.2	13.2	20.6	12.4	9.4	17.7	17.4
I	4th	27.7	25.9	7.0	22.5	12.9	15.6	24.6	12.7	9.1	14.6	17.3
S	5th	24.2	27.6	7.2	23.4	16.7	16.9	23.4	12.8	9.5	14.6	17.6
H	6th	24.4	28.4	6.7	20.6	18.3	16.7	14.5	12.7	10.5	14.1	16.7
M	7th	24.9	21.7	7.4	15.9	23.1	18.2	14.0	15.1	9.6	14.2	16.4
E	8th	22.0	17.6	7.0	15.9	19.3	15.1	13.3	15.0	11.7	13.6	15.1
N	9th	21.3	18.1	7.0	17.0	19.9	16.8	12.4	14.9	9.0	15.1	15.2
T	10th	18.0	15.2	8.7	16.9	17.6	17.9	11.0	15.6	8.6	13.3	14.3
Average Fifty Practice Trials		26.1	37.9	8.6	25.4	23.2	12.0	16.7	11.7	12.8	13.5	18.8

TABLE 32

REWARD GROUP

AVERAGE TIME PER TRIAL IN SECONDS FOR EACH SERIES OF FIVE TRIALS

Subject		*C.L.*	*H.P.*	*J.Pi*	*H.U.*	*E.Wa*	*H.R.*	*C.T.*	*V.F.*	*H.S.*	*S.R.*	*Average*
Series of five trials	1st	41.9	33.5	22.2	57.7	44.8	13.6	17.7	17.1	51.0	28.4	32.8
P	2nd	40.9	16.5	23.0	45.0	66.5	10.2	12.4	12.8	37.3	16.3	28.1
R	3rd	25.2	20.2	32.5	61.4	45.3	12.7	14.1	11.3	30.5	19.8	27.3
A	4th	26.7	17.6	27.6	38.4	61.3	11.6	14.7	12.6	28.0	....	26.5
C	5th	34.1	24.5	30.1	33.5	44.5	13.3	12.8	16.3	27.1	20.1	25.6
T	6th	28.2	18.0	24.5	25.0	37.5	12.5	12.5	17.8	18.8	16.1	21.1
I	7th	24.2	21.1	24.6	35.0	40.1	11.9	14.1	17.1	16.9	14.9	22.0
C	8th	24.4	23.5	22.5	31.6	50.0	10.9	13.9	16.1	13.8	14.9	22.2
E	9th	24.6	20.2	23.5	31.8	41.1	9.0	14.2	22.3	15.3	21.0	22.3
	10th	24.9	12.7	19.6	35.4	47.7	10.1	14.0	15.1	16.6	15.9	21.2
	1st	27.1	8.6	19.7	48.0	38.6	11.2	13.3	18.3	24.9	17.5	22.7
	2nd	27.8	11.3	27.4	25.6	37.3	11.0	16.7	18.5	15.4	10.5	20.2
R	3rd	22.6	11.4	25.5	24.6	50.8	10.4	16.5	13.9	13.4	7.9	19.7
E	4th	21.0	13.4	21.7	20.1	41.0	10.7	21.2	18.3	10.6	8.8	18.7
W	5th	23.9	12.1	18.1	21.9	44.8	10.2	16.6	12.2	9.3	9.2	17.8
A	6th	27.4	12.4	19.2	22.3	26.2	12.5	16.3	14.6	10.9	9.5	17.1
R	7th	25.7	10.2	19.2	26.6	34.7	11.4	16.1	12.3	9.9	12.3	17.8
D	8th	21.3	12.1	19.6	22.7	30.9	12.9	15.2	23.0	10.8	12.6	18.1
	9th	23.7	13.5	19.4	25.0	38.0	14.8	17.7	28.6	10.3	14.2	20.5
	10th	29.7	14.2	17.7	....	....	13.9	16.4	21.5	10.7	11.3	16.9
Average Fifty Practice Trials		29.5	20.8	25.0	39.5	47.9	11.6	14.0	15.9	25.5	16.7	24.6

TABLE 33

GUESS-WITH-PUNISHMENT GROUP

AVERAGE TIME PER TRIAL IN SECONDS FOR EACH SERIES OF FIVE TRIALS

Subject		*E.Be*	*I.B.*	*L.R.*	*B.M.*	*S.S.*	*L.L.*	*H.B.*	*F.Ga*	*V.C.*	*A.G.*	*Average*
Series of five trials	1st	23.6	37.5	24.6	25.0	14.7	59.9	12.3	27.9	19.1	26.4	27.1
P	2nd	12.5	32.5	20.1	....	10.3	61.3	27.9	31.6	10.2	15.6	24.7
R	3rd	20.4	27.5	27.7	16.0	8.9	55.4	18.7	38.8	11.7	16.4	24.2
A	4th	15.4	25.9	24.6	17.0	8.9	57.6	22.6	34.1	10.0	13.5	23.0
C	5th	14.1	26.2	25.4	13.3	8.8	44.6	18.9	35.3	10.6	11.5	20.9
T	6th	11.5	22.2	21.4	....	8.6	30.0	14.5	32.9	9.6	12.5	18.1
I	7th	12.0	21.2	23.1	19.0	8.5	46.2	10.3	32.9	11.7	12.8	19.8
C	8th	11.2	21.6	18.4	15.8	7.6	48.6	9.0	37.3	10.2	12.4	19.2
E	9th	16.0	19.6	23.2	17.0	8.0	43.6	8.0	23.1	10.1	12.1	18.1
	10th	15.5	15.4	17.9	13.0	8.3	48.0	9.1	23.4	9.4	11.3	17.1
P	1st	16.8	31.7	25.8	16.5	11.6	....	10.6	23.1	13.0	10.8	17.8
U	2nd	20.1	24.7	27.9	18.8	17.6	47.8	10.2	31.8	18.2	10.9	22.8
G N	3rd	15.4	28.5	29.3	23.0	15.8	51.4	9.0	22.3	17.8	11.6	22.4
U w I	4th	9.3	25.9	24.7	20.6	21.0	66.9	10.0	17.4	20.7	13.4	23.0
E i S	5th	9.0	23.7	24.6	21.6	20.4	60.5	9.5	12.1	20.8	13.6	21.6
S t H	6th	16.4	22.2	20.9	22.4	21.2	54.9	9.8	10.2	12.4	14.5	20.5
S h M	7th	9.8	20.9	19.7	28.6	17.8	58.3	10.0	9.7	17.1	15.8	20.8
E	8th	10.7	17.9	23.6	26.7	19.3	42.4	9.8	9.4	16.7	15.9	19.2
N	9th	8.9	21.0	19.4	30.7	20.7	35.0	8.9	9.6	21.1	16.4	19.2
T	10th	8.6	16.6	....	29.4	21.1	33.1	8.0	10.9	21.9	16.3	18.4
Average Fifty Practice Trials		15.2	25.0	22.6	17.0	9.3	49.5	15.1	31.7	11.3	14.5	21.1

TABLE 34

Told-with-Punishment Group

Average Time Per Trial in Seconds for Each Series of Five Trials

Subject		*M.I.*	*E.G.*	*E.Re*	*J.Po*	*E.We*	*I.M.*	*E.S.*	*E.Ro*	*M.C.S.*	*B.C.*	*Average*
Series of five trials	1st	21.7	17.3	20.7	22.3	....	9.9	36.9	10.2	36.9	34.8	23.4
P	2nd	22.8	17.2	13.7	23.5	13.2	7.9	45.9	11.9	22.0	32.0	21.0
R	3rd	22.5	15.9	11.6	24.9	8.4	8.9	50.5	14.2	24.6	31.8	21.3
A	4th	20.2	17.0	14.0	27.4	9.1	7.6	50.3	17.0	21.7	34.1	21.8
C	5th	19.0	16.1	10.5	14.1	9.4	8.4	50.1	16.1	22.7	31.2	19.8
T	6th	17.4	17.7	9.6	23.5	8.4	7.3	....	17.8	23.9	35.2	17.9
I	7th	16.7	17.3	10.7	18.4	8.1	7.4	43.4	20.5	23.3	32.8	19.9
C	8th	16.8	17.3	9.2	17.8	9.0	7.6	43.4	19.9	21.6	34.3	19.7
E	9th	14.8	14.0	13.3	15.9	8.3	7.1	43.9	22.1	24.3	32.8	19.7
	10th	13.9	12.6	10.2	17.8	10.9	6.8	40.5	19.7	24.6	31.0	18.8
P	1st	16.8	....	12.7	13.2	10.1	6.7	60.5	18.3	21.1	32.5	21.3
U	2nd	10.9	14.2	11.1	15.5	8.3	10.5	63.1	14.6	21.1	38.0	20.7
N	3rd	16.0	17.1	13.5	21.9	9.0	9.6	47.8	13.4	24.9	42.4	21.6
T w I	4th	14.8	16.7	11.6	19.1	8.2	10.2	49.3	14.7	23.5	40.8	20.9
O i S	5th	15.5	16.4	11.2	23.8	10.4	9.7	53.4	13.9	24.6	40.7	22.0
L t H	6th	14.6	21.2	11.3	24.7	9.0	9.6	50.3	15.6	26.0	35.9	21.8
D h M	7th	13.5	17.4	11.7	29.0	10.0	10.6	59.9	13.2	25.8	36.2	22.7
E	8th	13.5	18.2	11.9	27.5	12.8	9.8	53.2	13.2	28.2	34.4	22.3
N	9th	13.3	17.1	10.6	24.7	11.1	9.7	48.9	15.8	26.9	35.4	21.4
T	10th	13.5	19.4	11.2	19.4	11.4	10.5	55.9	15.4	28.4	33.2	21.8
Average Fifty Practice Trials		18.6	16.2	12.4	20.6	9.4	7.9	45.0	16.9	24.6	33.0	20.5

TABLE 35

KNOWLEDGE GROUP

AVERAGE TIME PER TRIAL IN SECONDS FOR EACH SERIES OF FIVE TRIALS

Subject		*M.K.*	*E.V.*	*L.W.*	*E.H.H.*	*P.H.*	*E.M.*	*J.F.*	*E.Bj*	*M.J.*	*T.L.*	*Average*
Series of five trials	1st	11.2	31.4	27.0	20.3	12.6	24.6	10.8	6.9	13.3	10.4	16.9
P	2nd	9.7	21.4	29.3	28.6	9.4	31.2	13.1	6.4	10.8	11.7	17.2
R	3rd	9.4	21.1	27.5	20.1	10.0	26.5	15.1	6.9	10.0	11.3	15.8
A	4th	9.5	14.4	27.1	19.6	9.2	20.4	14.7	6.7	13.4	8.9	14.4
C	5th	8.3	15.5	25.2	16.7	9.7	22.2	16.2	7.8	12.2	10.1	14.4
T	6th	8.4	13.8	29.7	15.8	8.5	21.8	13.7	7.6	8.4	7.6	13.5
I	7th	8.9	13.2	28.8	14.9	9.8	25.9	13.9	7.4	9.5	8.2	14.1
C	8th	9.2	12.3	25.1	14.1	10.9	30.8	12.9	6.9	9.2	8.5	14.0
E	9th	8.6	11.8	33.4	13.9	9.3	25.0	12.3	6.9	9.4	8.2	13.9
	10th	7.9	10.3	31.2	17.7	11.0	20.5	11.9	7.8	10.1	9.1	13.8
K	1st	8.6	17.2	22.3	16.7	10.6	15.8	15.5	5.4	7.8	8.8	12.9
N	2nd	9.4	18.0	26.9	13.2	9.8	26.8	15.6	5.8	7.7	14.2	14.7
O	3rd	10.0	16.6	23.2	12.3	8.5	22.1	11.9	7.0	8.8	14.5	13.5
W	4th	8.8	16.1	24.8	11.1	8.8	26.2	11.7	6.8	8.9	12.2	13.5
L	5th	9.2	14.6	26.1	10.3	9.6	30.5	9.8	6.2	7.6	14.0	13.8
E	6th	10.9	12.6	19.9	15.1	9.0	36.4	10.0	6.1	8.0	13.8	14.2
D	7th	8.5	12.4	24.5	15.9	10.0	31.7	10.1	5.3	8.8	12.4	14.0
G	8th	8.5	11.0	22.9	15.0	9.7	33.2	10.8	6.4	9.5	15.5	14.3
E	9th	8.8	10.7	22.5	10.9	8.9	33.0	9.7	5.9	9.0	18.3	13.8
	10th	8.8	12.4	19.6	13.0	8.9	20.9	12.0	6.1	9.7	17.2	12.9
Average Fifty Practice Trials		9.1	16.5	28.4	18.2	10.0	24.9	13.5	7.1	10.6	9.4	14.8

TABLE 36

AVERAGE ERROR OF THE LAST FIVE TRIALS AS A PERCENTAGE OF THE AVERAGE OF THE FIRST FIVE TRIALS OF THE INCENTIVE SERIES

Group	*Subjects*										*Average*
Control	H.Q. 217	S.O. 111	I.L. 271	V.K. 89	I.R. 205	B.E. 100	H.A.K. 33	M.R. 98	M.M.S. 184	C.G. 242	155
Punishment	I.T. 23	F.K. 19	M.W.S. 4	D.H. 18	F.Gr 36	E.M.H. 14	H.R.K. 56	D.G. 21	V.L. 38	M.M. 9	24
Reward	C.L. 56	H.P. 35	J.Pi 16	H.U. 18	E.Wa 90	H.R. 40	C.T. 41	V.F. 38	H.S. 11	S.R. 18	36
Guess-with-Punishment	E.Be 13	I.B. 35	L.R. 12	B.M. 18	S.S. 38	L.L. 15	H.B. 31	F.Ga 26	V.C. 39	A.G. 23	25
Told-with-Punishment	M.I. 16	E.G. 18	E.Re 9	J.Po 14	E.We 15	I.M. 80	E.S. 25	E.Ro 9	M.C.S. 35	B.C. 31	25
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